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Sakakibara et al.

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(45) **Date of Patent: May 22, 2012**

(54) **IMAGE PRINTING DEVICE**

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(30) **Foreign Application Priority Data**

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(51) **Int. Cl.**
B41J 29/393 (2006.01)
B41J 29/38 (2006.01)

(52) **U.S. Cl.** **347/16**; 314/19

(58) **Field of Classification Search** 347/16, 347/19
See application file for complete search history.

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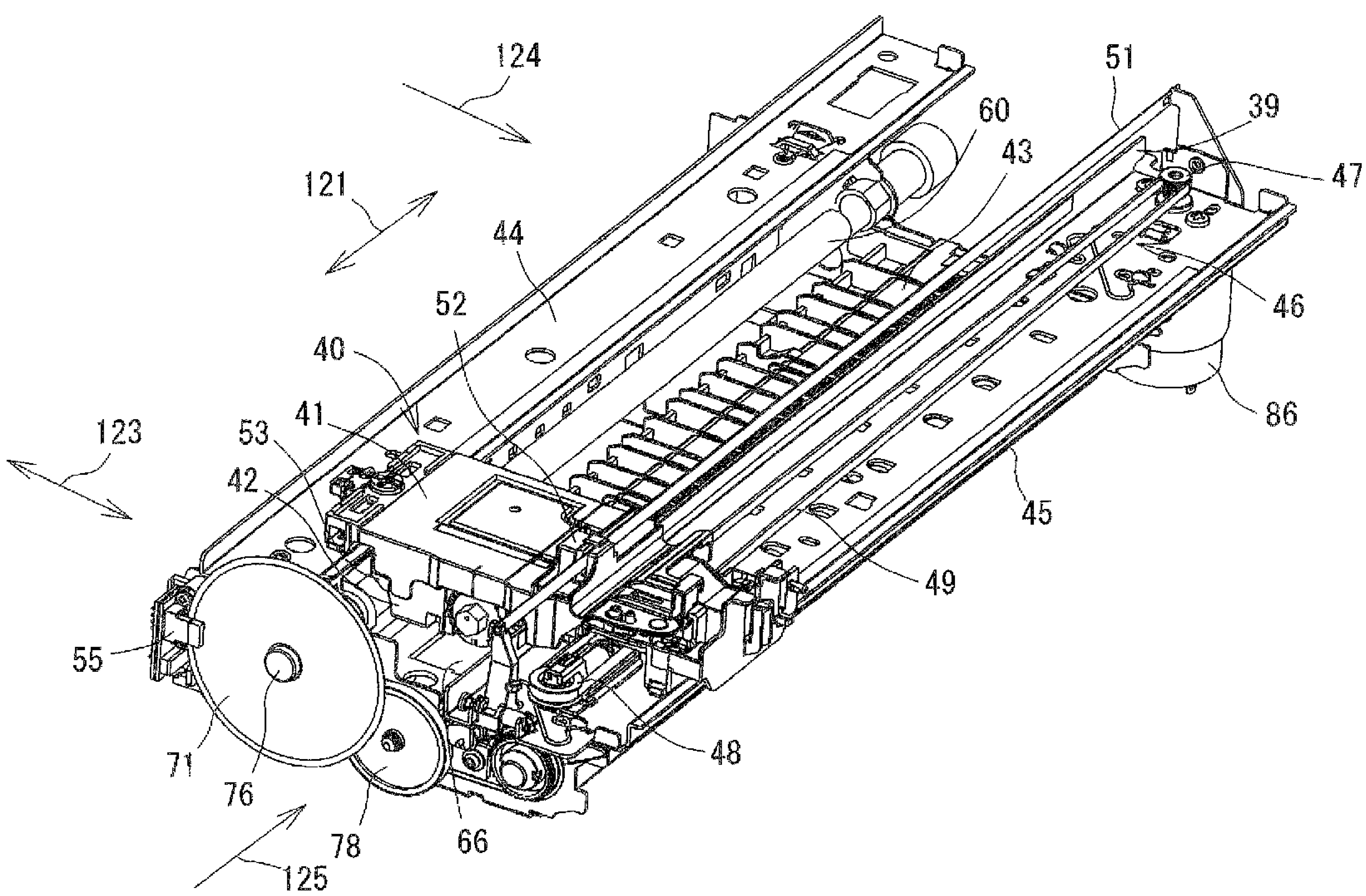
(74) *Attorney, Agent, or Firm* — Baker Botts L.L.P.

(57) **ABSTRACT**

an image printing device comprises a transfer roller configured to transfer a printing medium in a transfer direction, a first sensor configured to detect a rotation amount of the transfer roller, a carriage mounted with a printhead. The image printing device further comprises a second sensor mounted to the carriage and configured to detect the printing medium. The image printing device further comprises a reference member disposed at a position opposing to the second sensor and a drive transmission mechanism configured to move the reference member in conjunction with a rotation of the transfer roller. The image printing device determines a position of an origin of the transfer roller based on detection results of the first sensor and the second sensor.

7 Claims, 18 Drawing Sheets



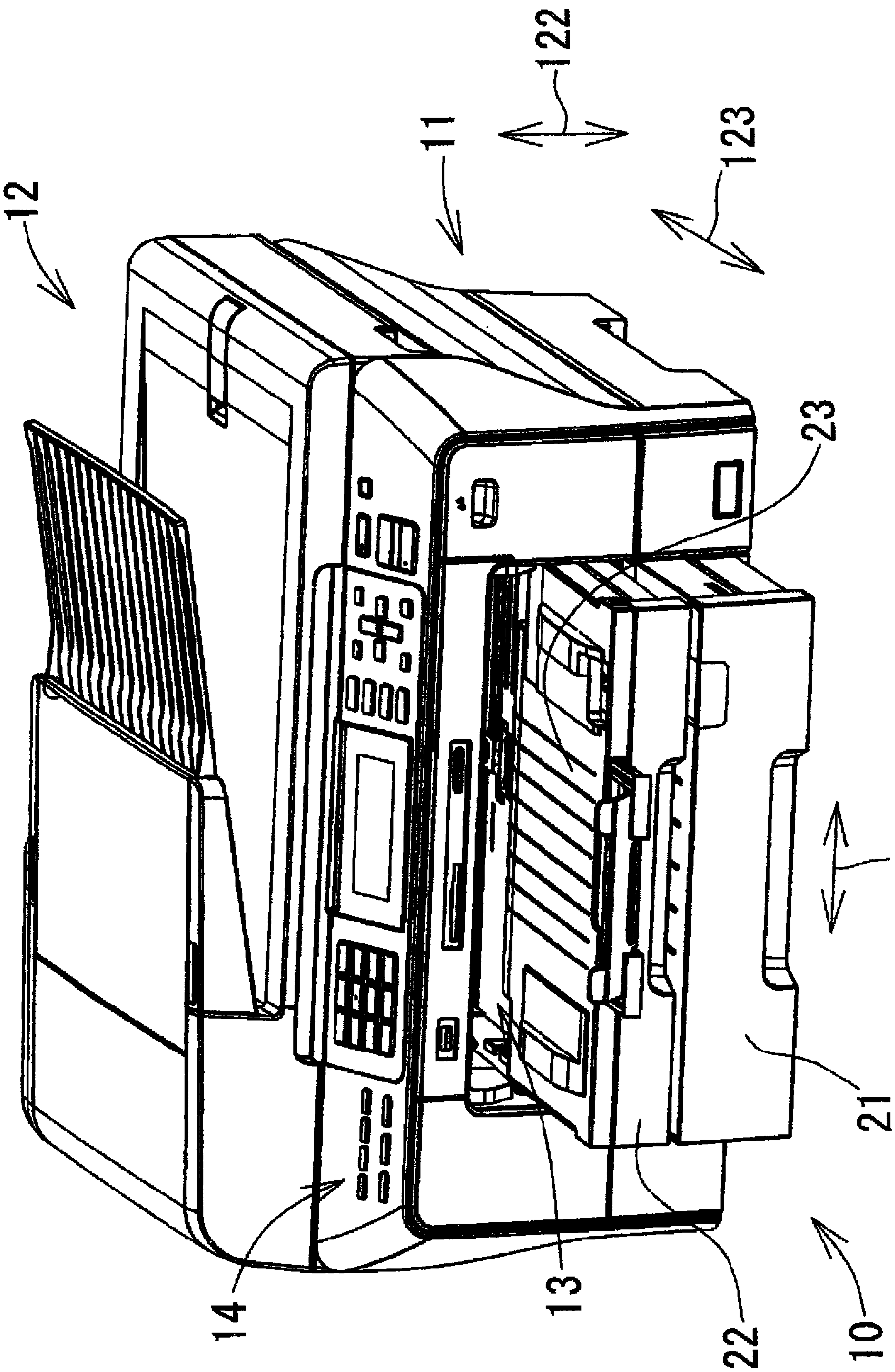


Fig. 1

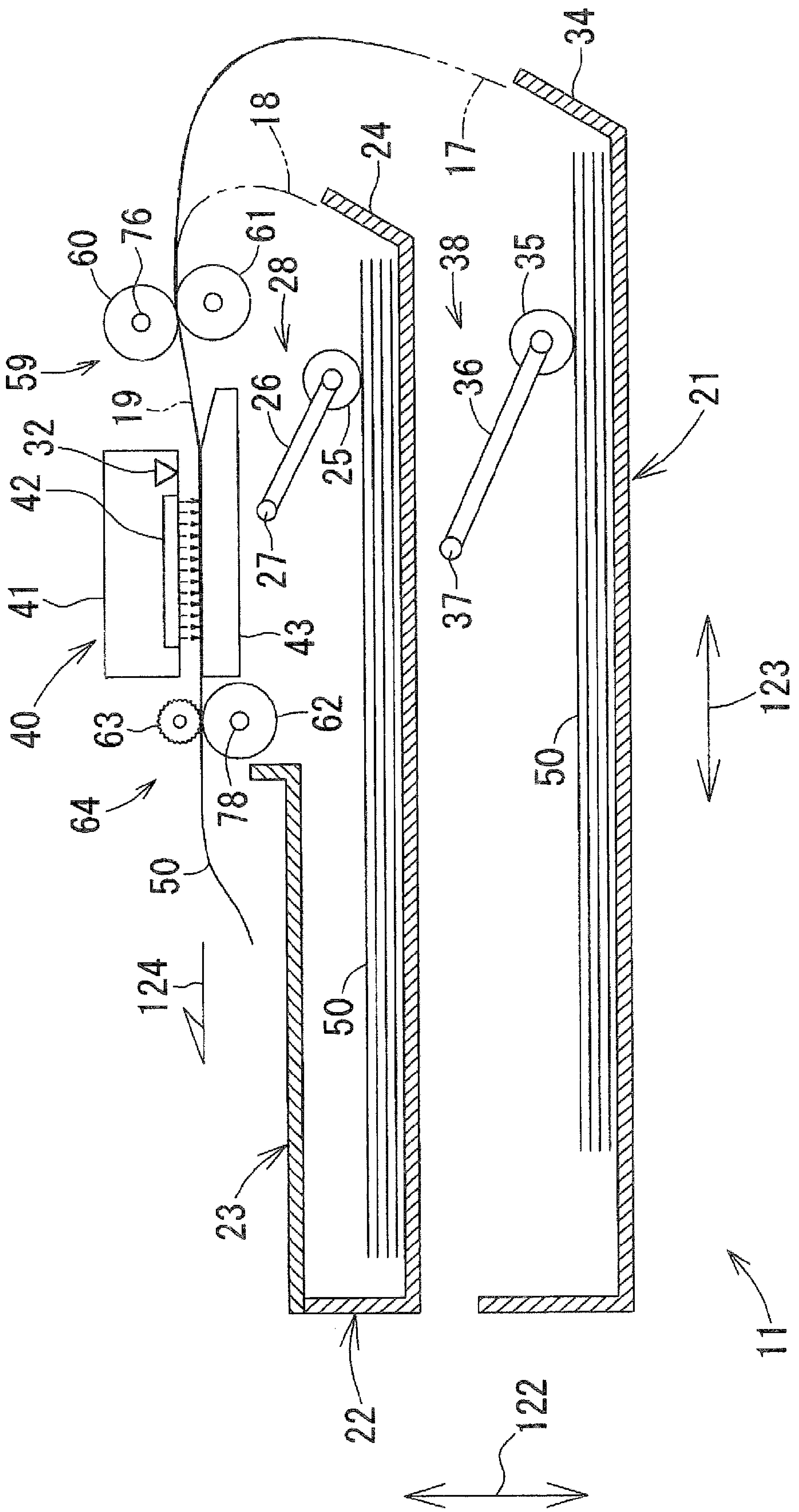


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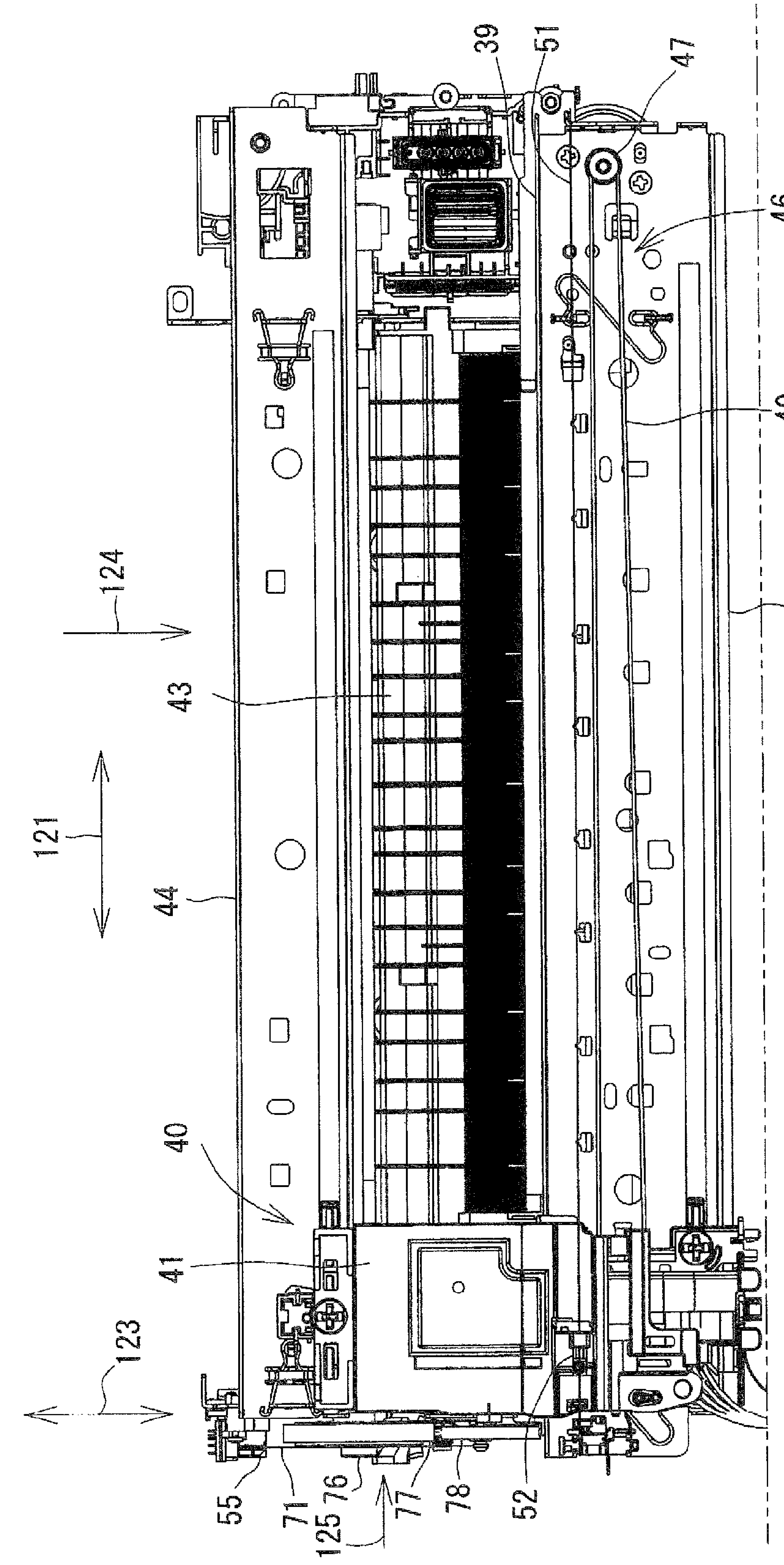
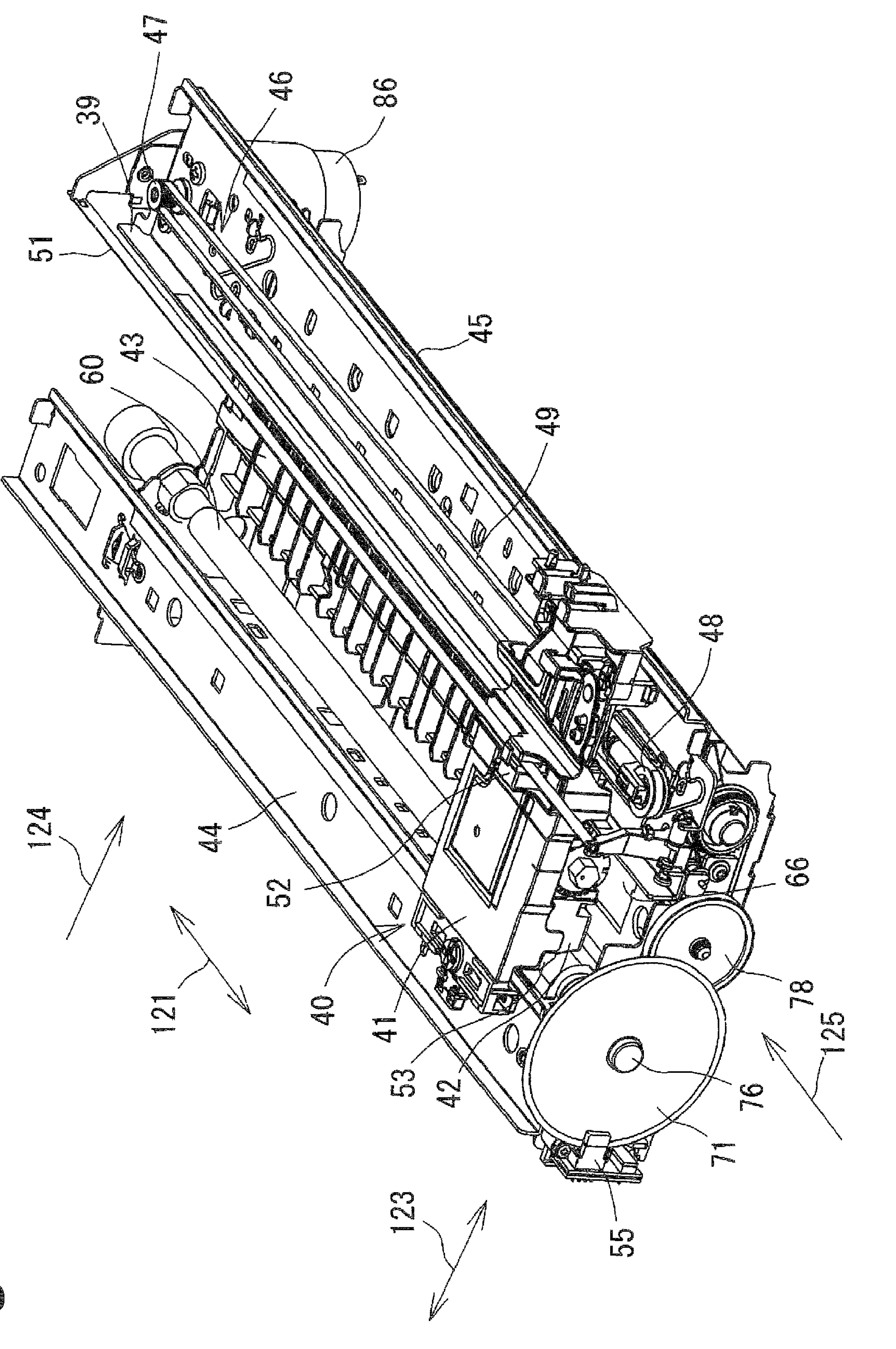
Fig. 2

Fig. 3

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123
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Fig. 4

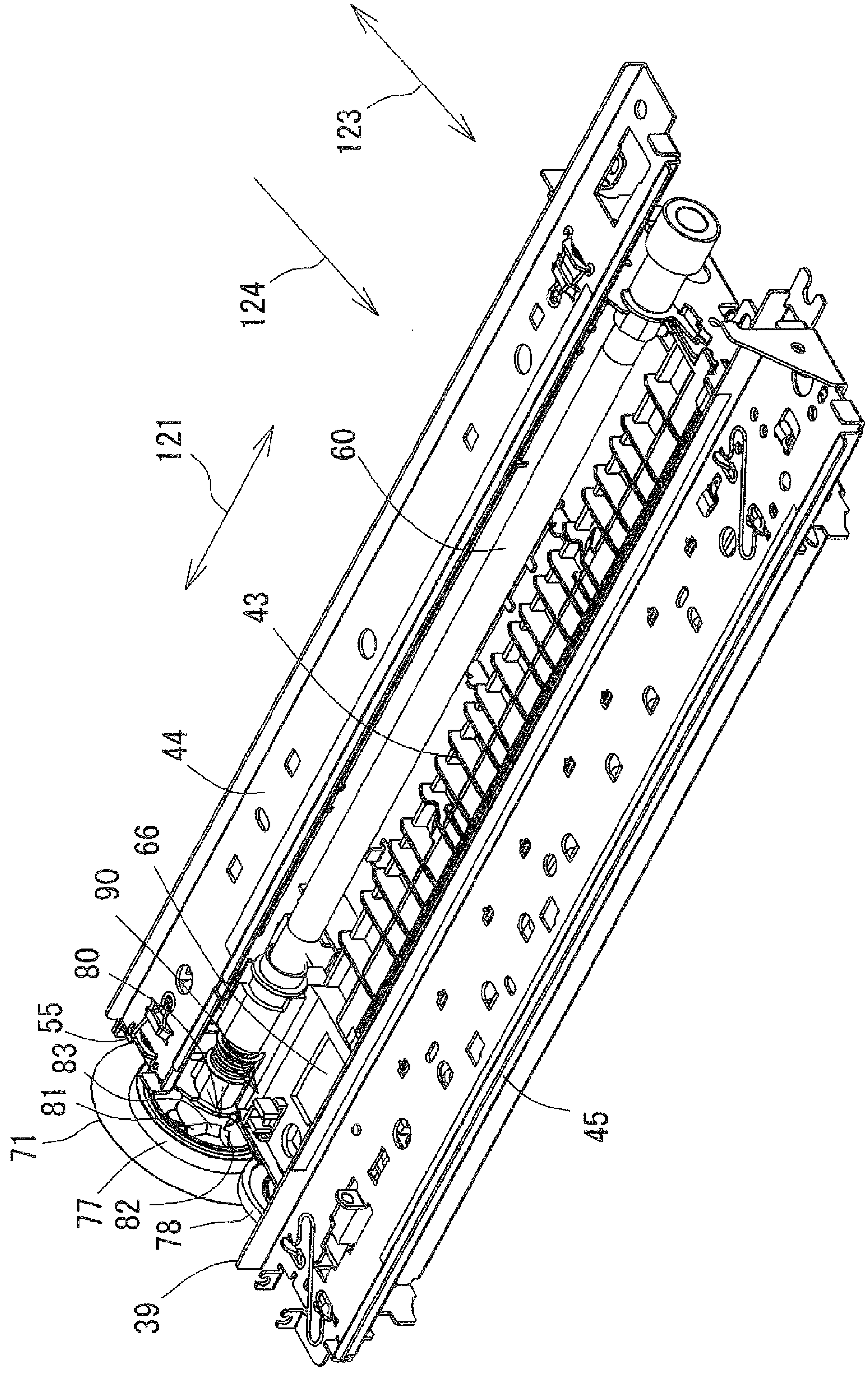


Fig. 5

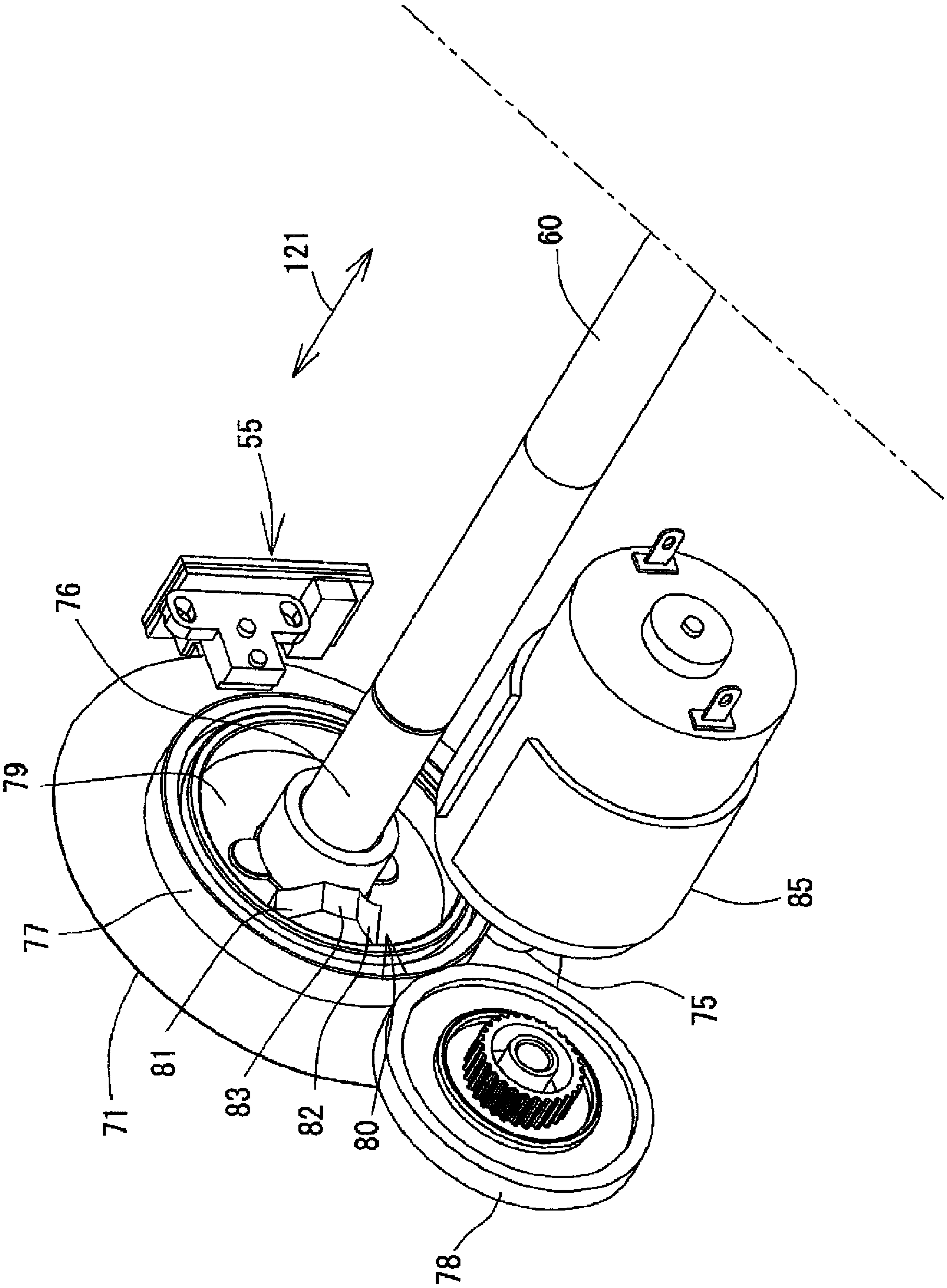


Fig. 6

Fig. 7A

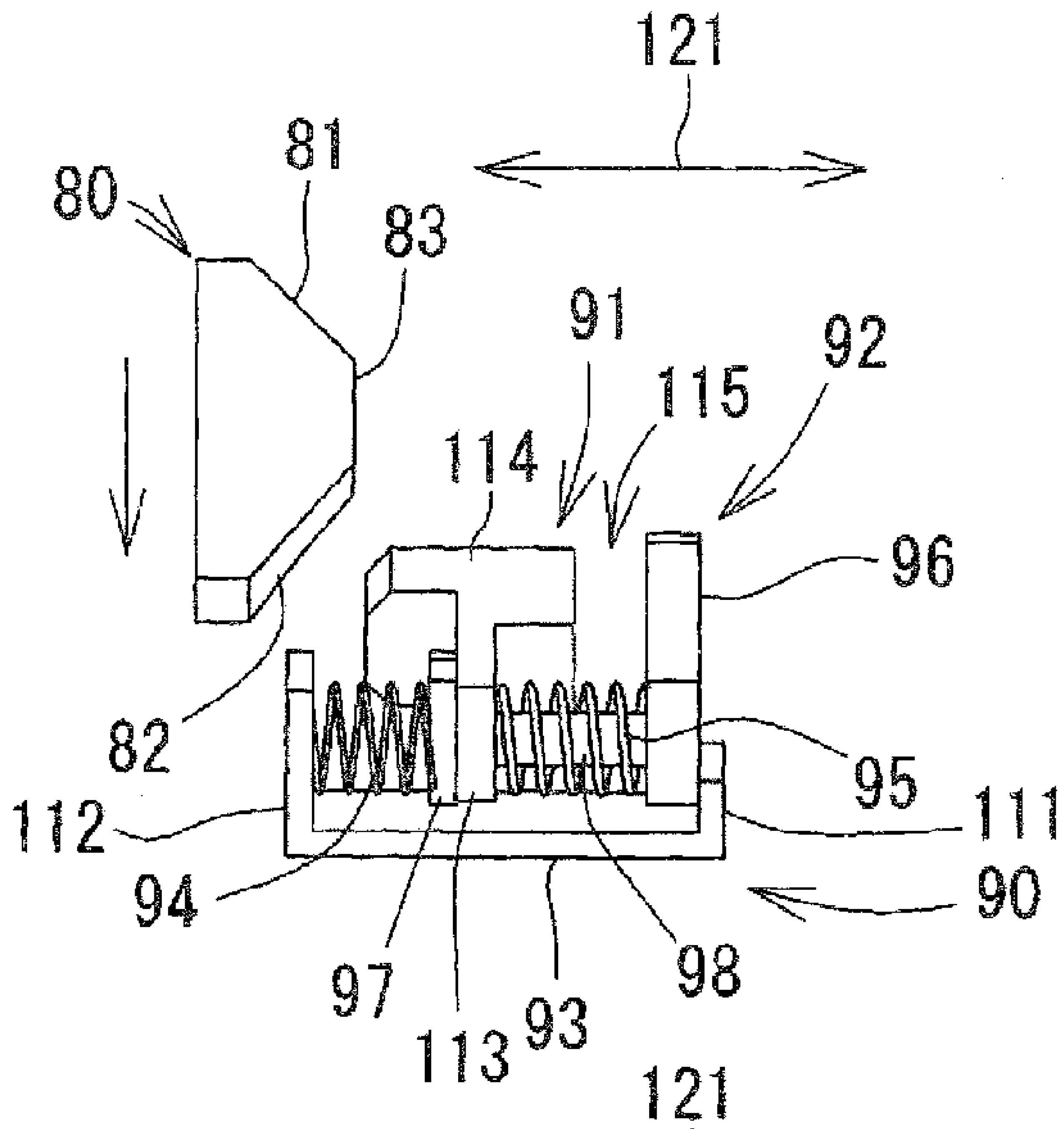


Fig. 7B

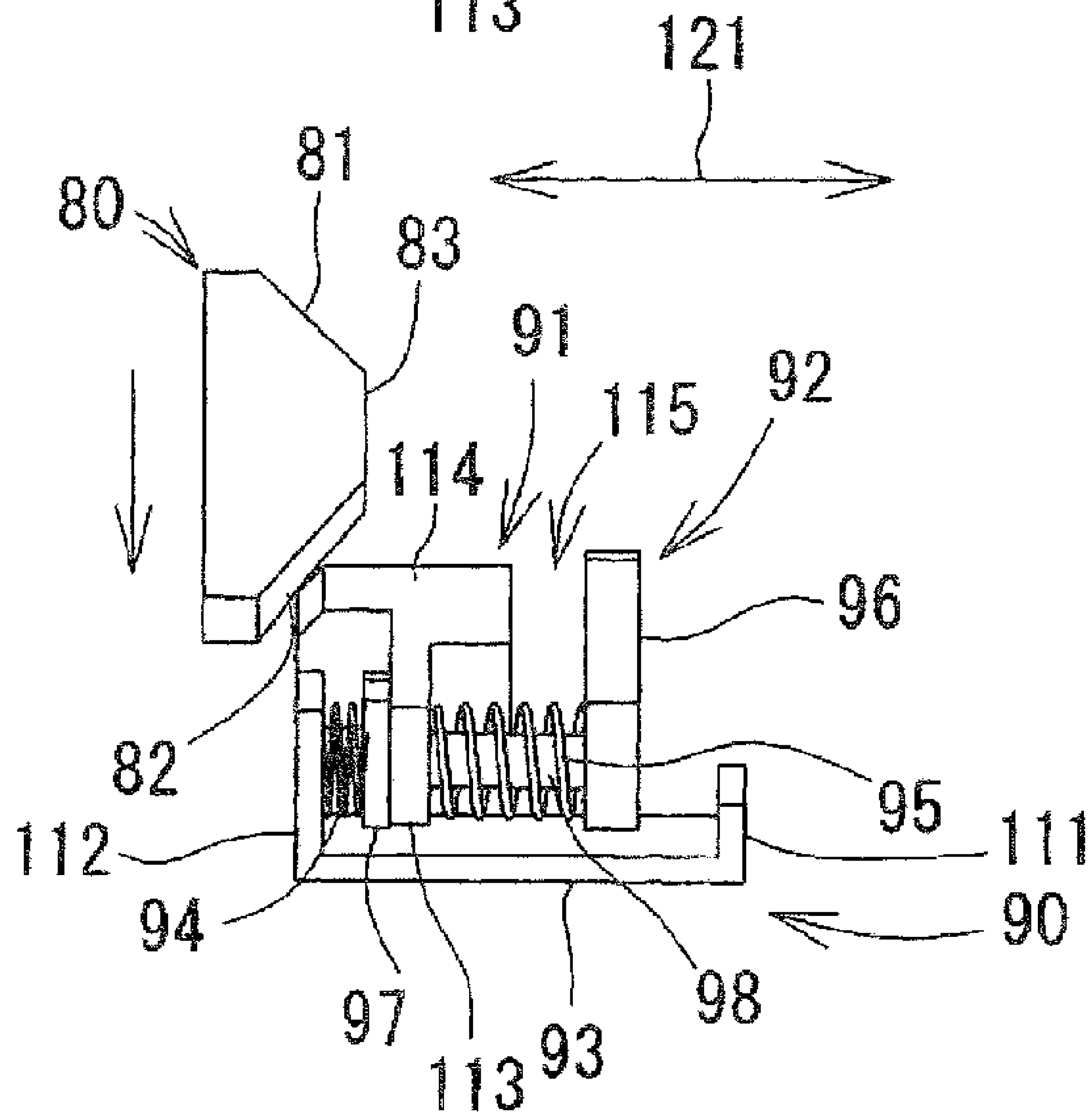


Fig. 7C

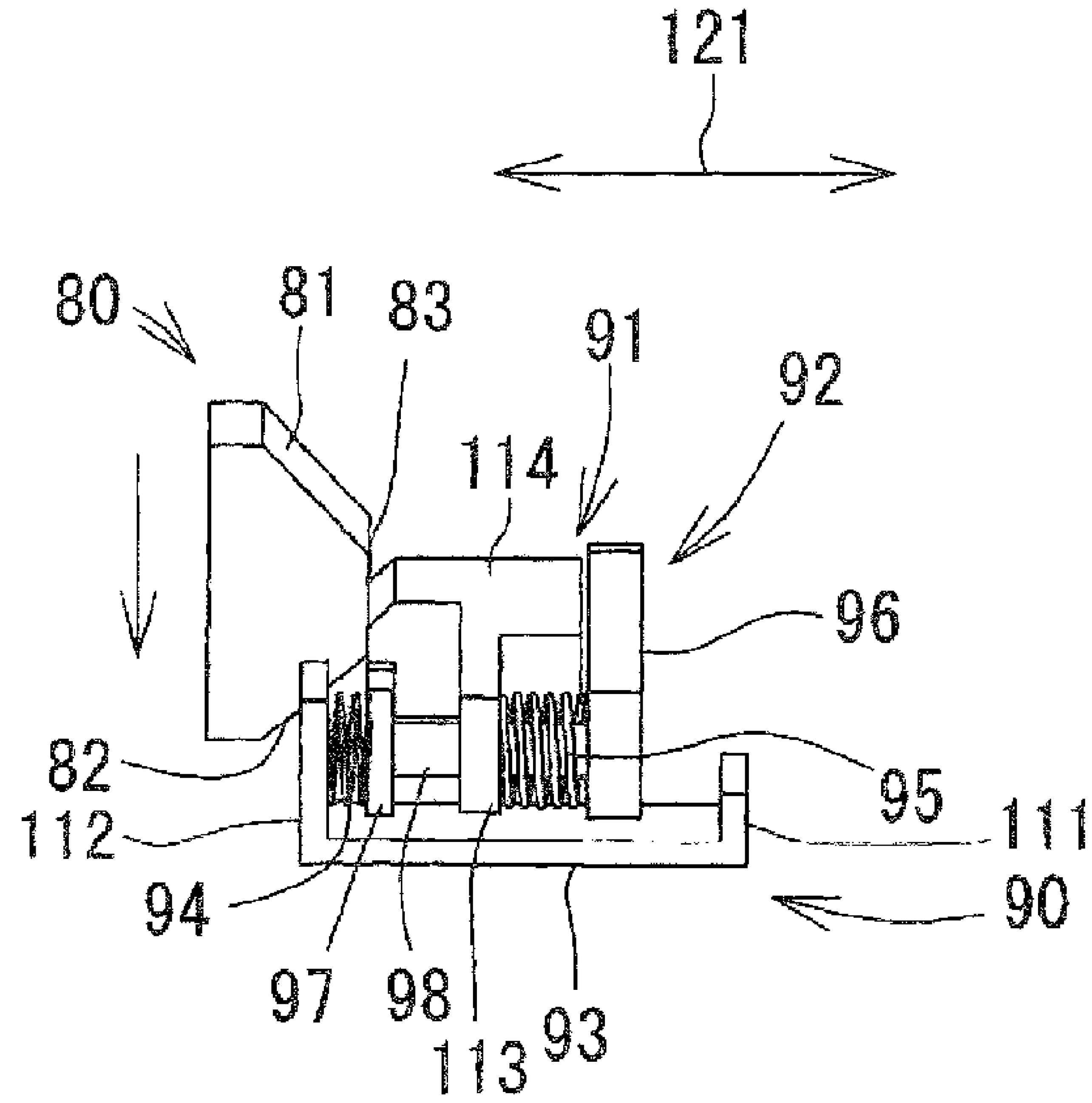


Fig. 8

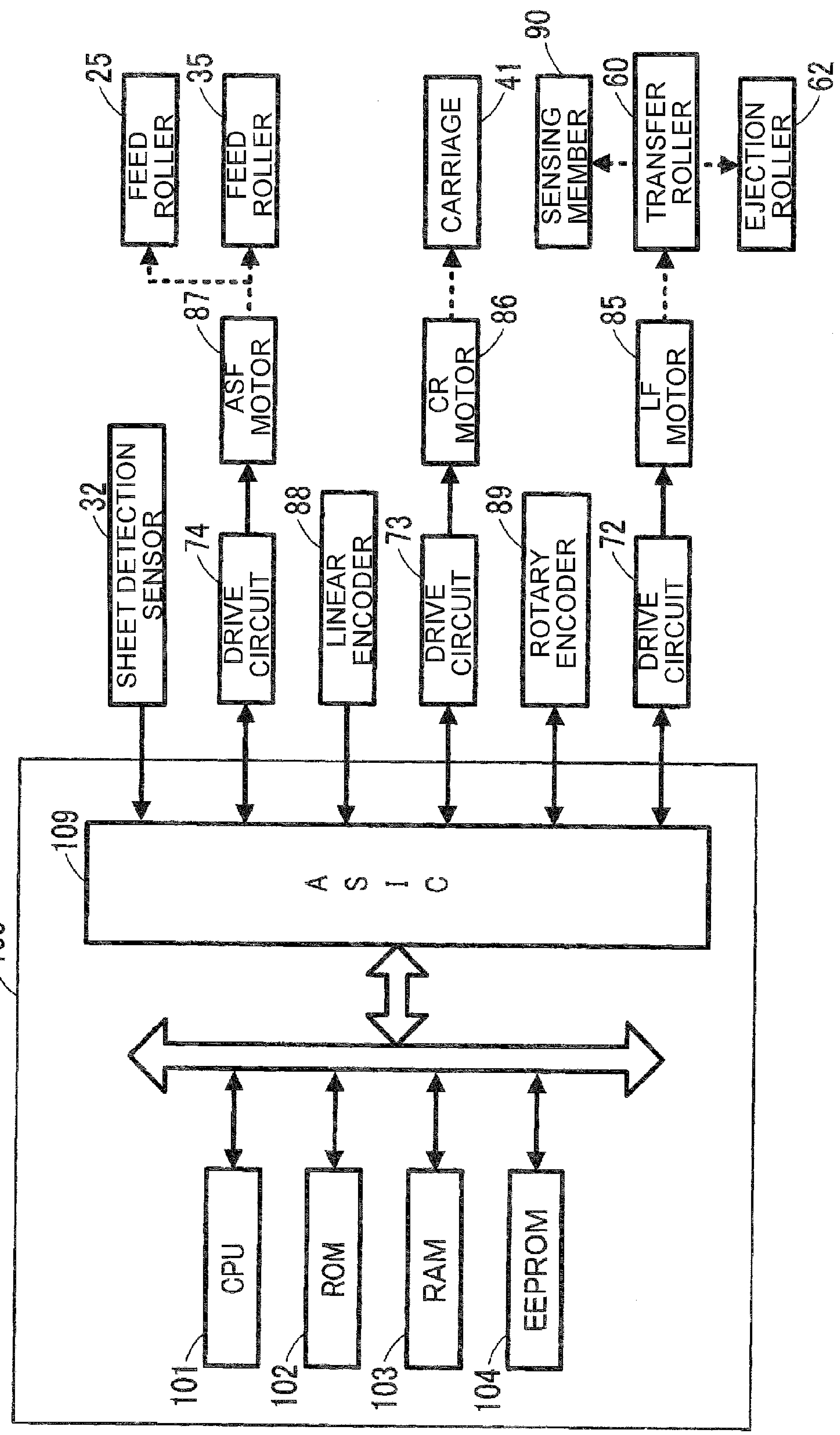

FEED ROLLER
25
FEED ROLLER
35
CARRIAGE
41
SENSING MEMBER
90
TRANSFER ROLLER
60
EJECTION ROLLER
62
ASF MOTOR
87
CR MOTOR
86
LF MOTOR
85
SHEET DETECTION SENSOR
32
DRIVE CIRCUIT
74
LINEAR ENCODER
88
DRIVE CIRCUIT
73
ROTARY ENCODER
89
DRIVE CIRCUIT
72
ASIC
109
100
CPU
101
ROM
102
RAM
103
EEPROM
104

Fig. 9A

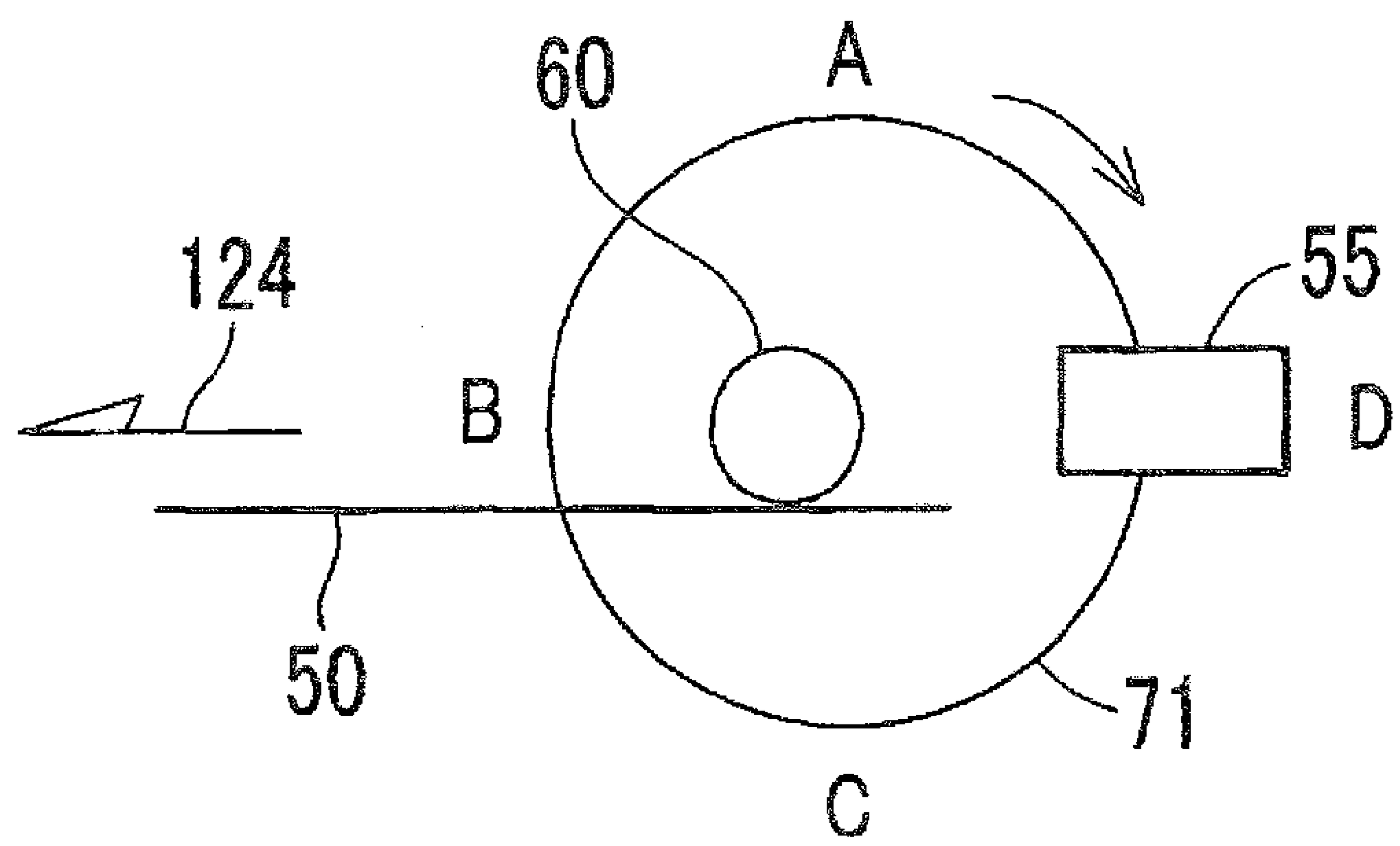


Fig. 9B

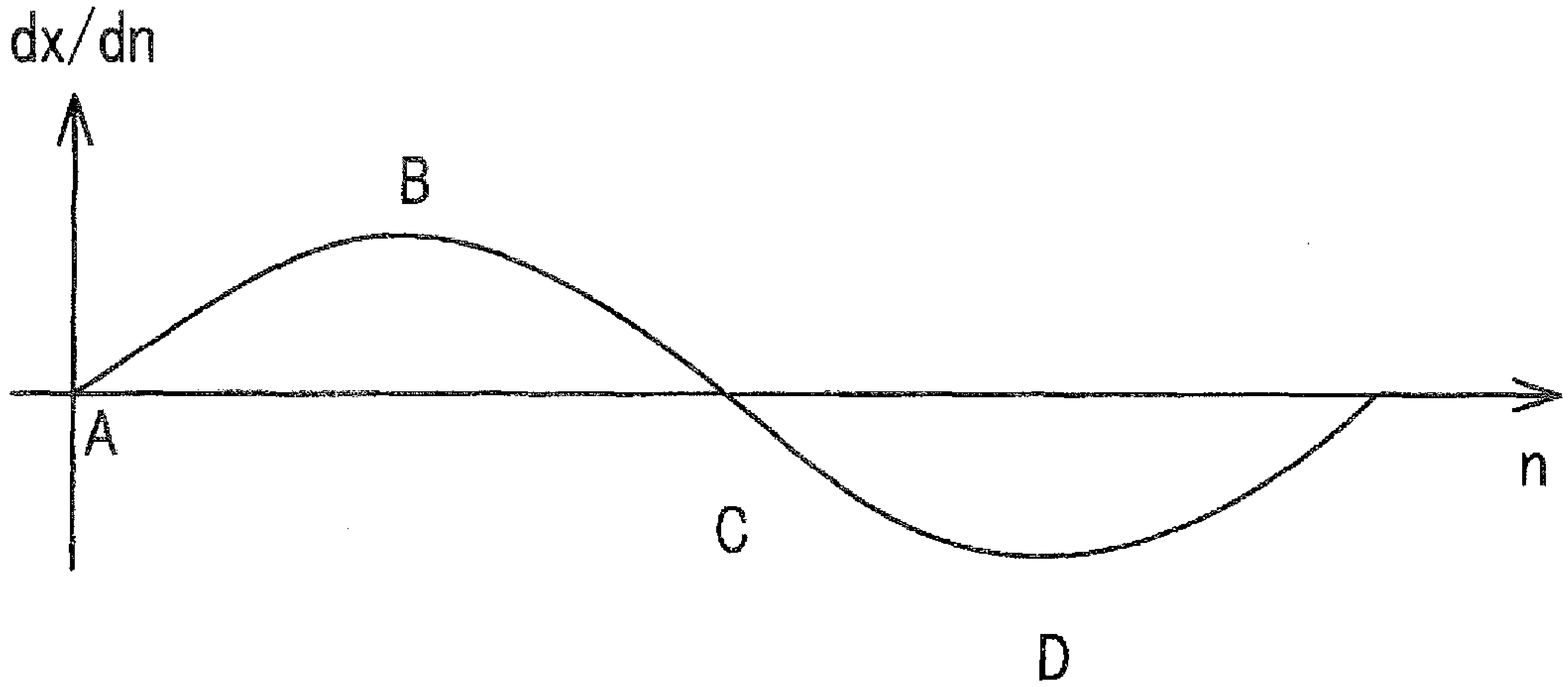


Fig. 10A

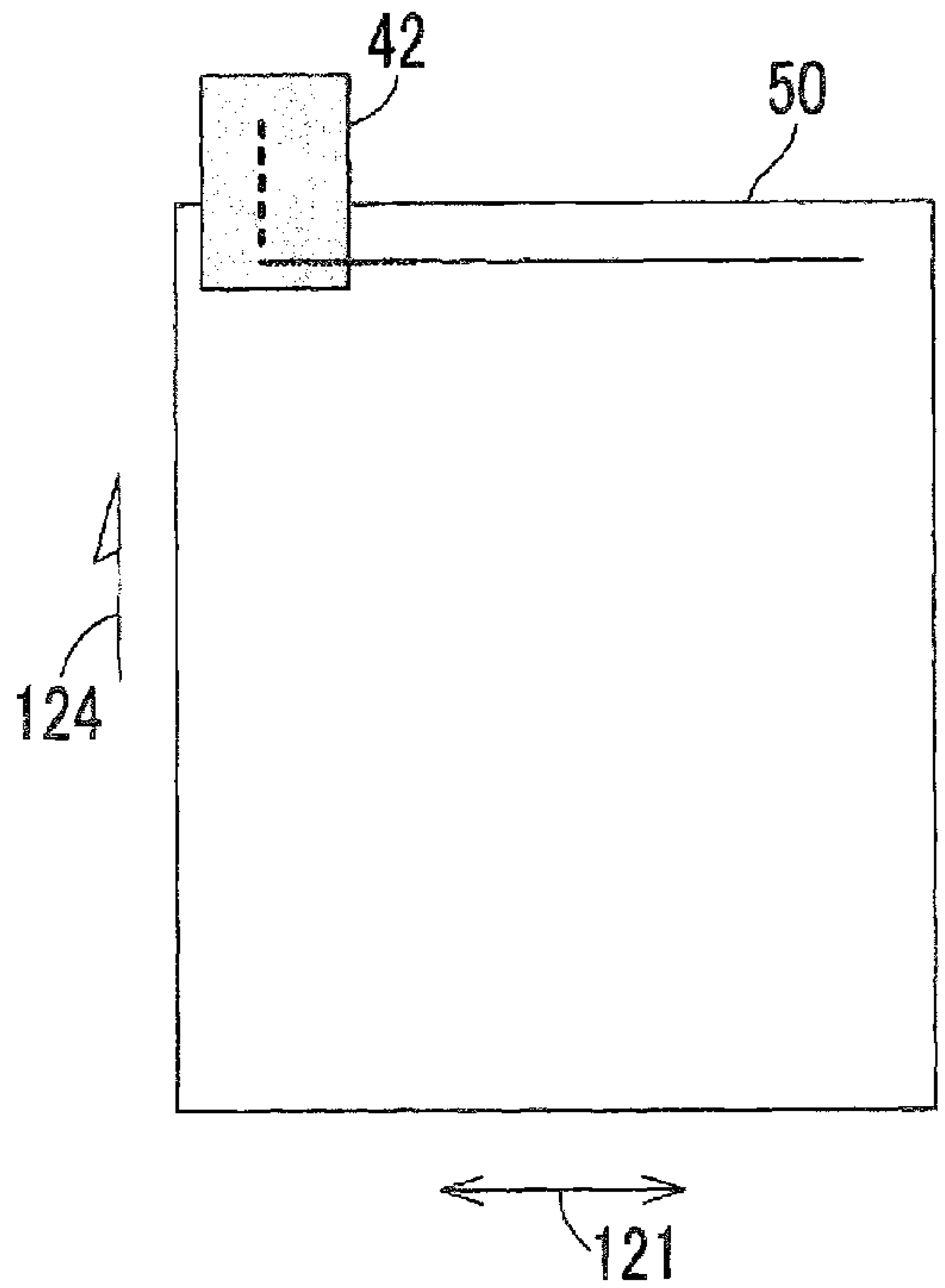


Fig. 10B

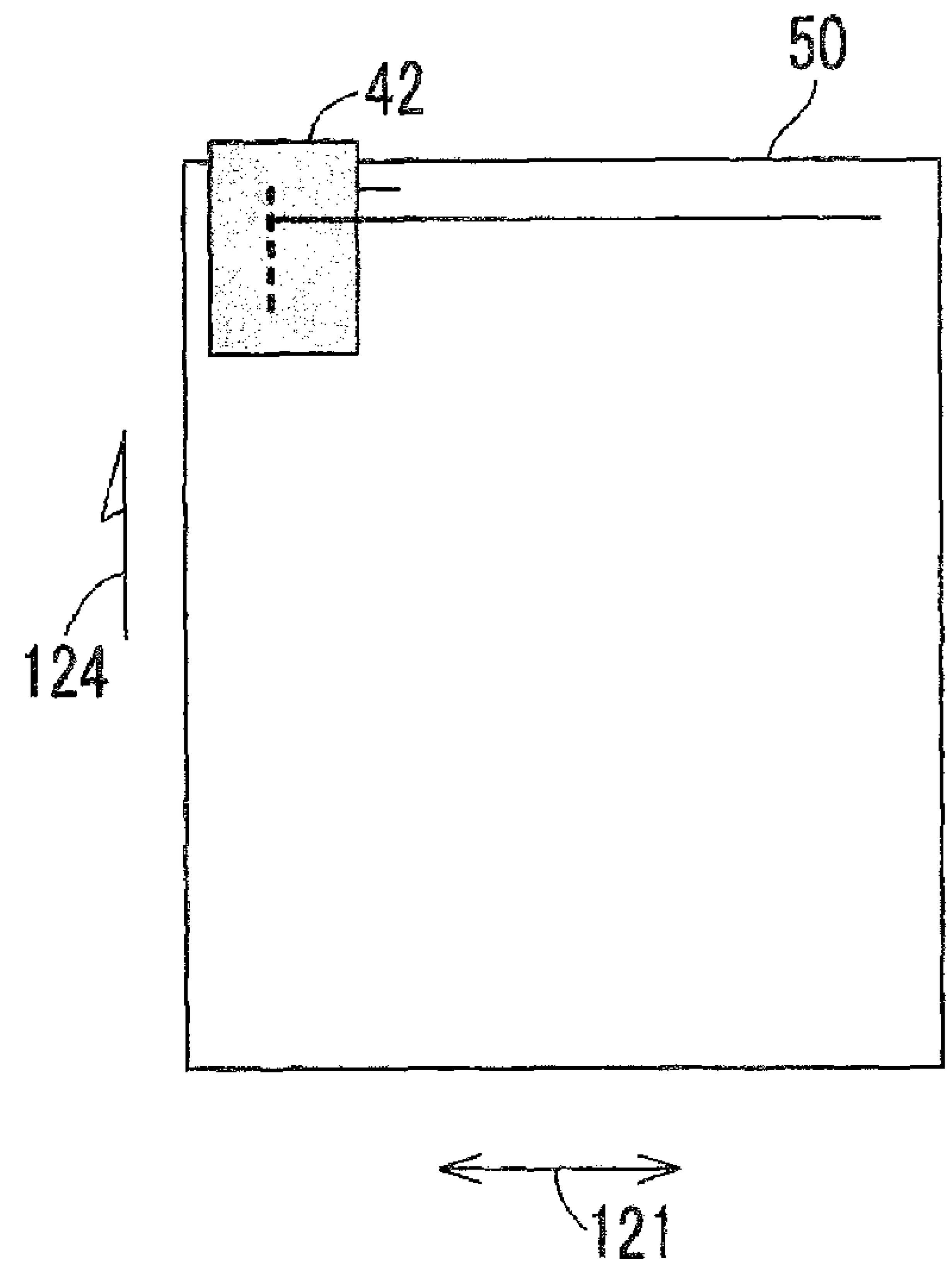


Fig. 10C

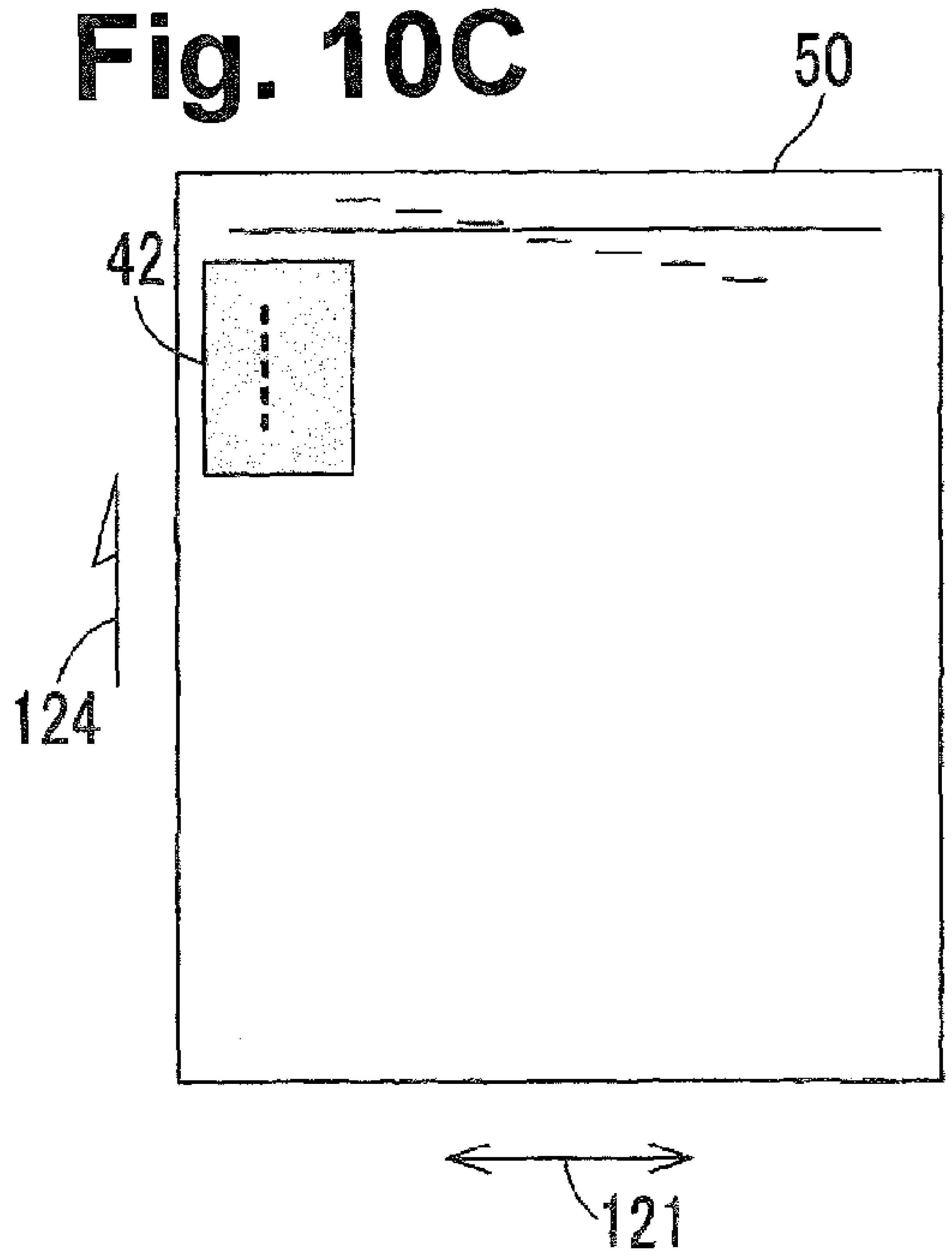


Fig. 10D

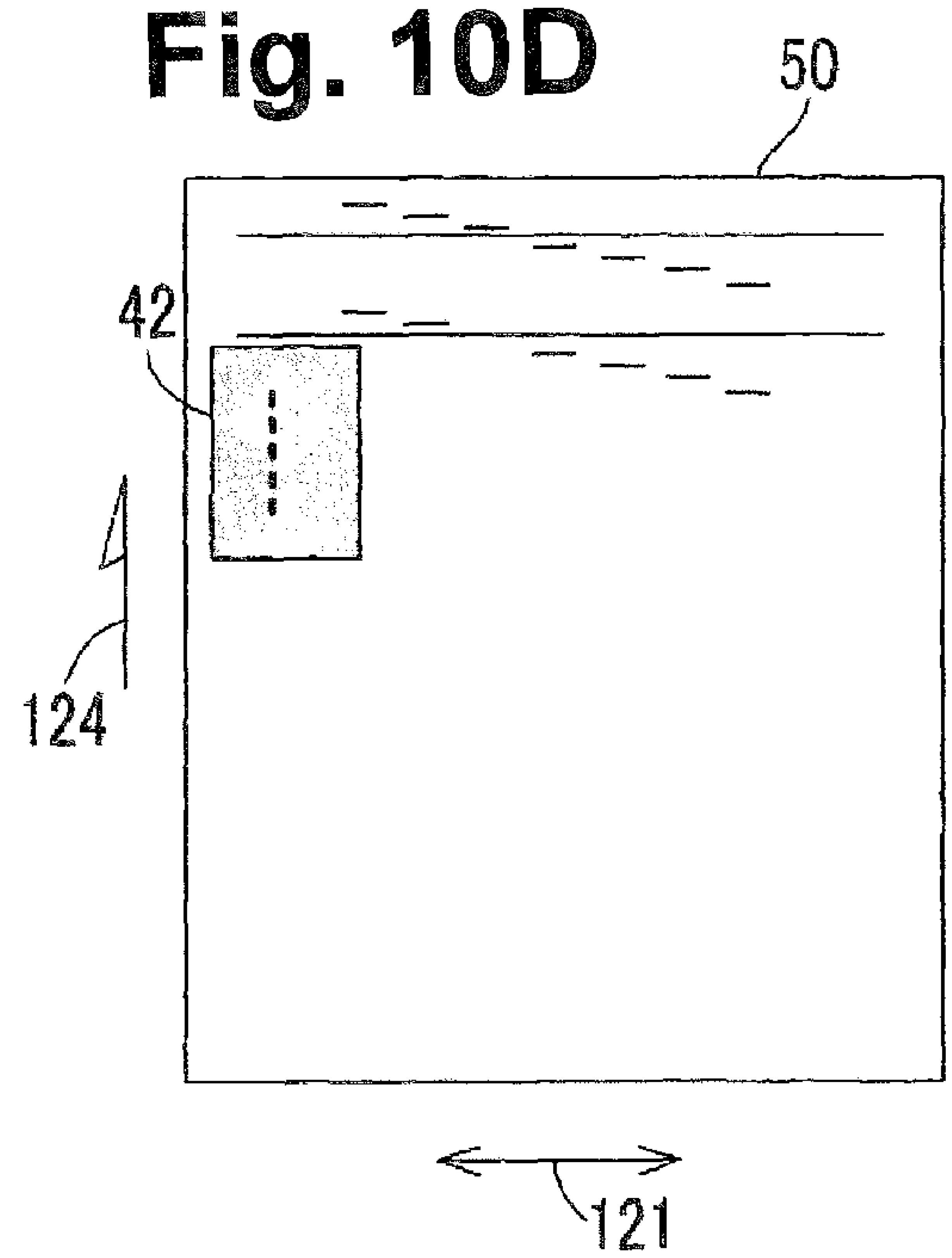


Fig. 11A

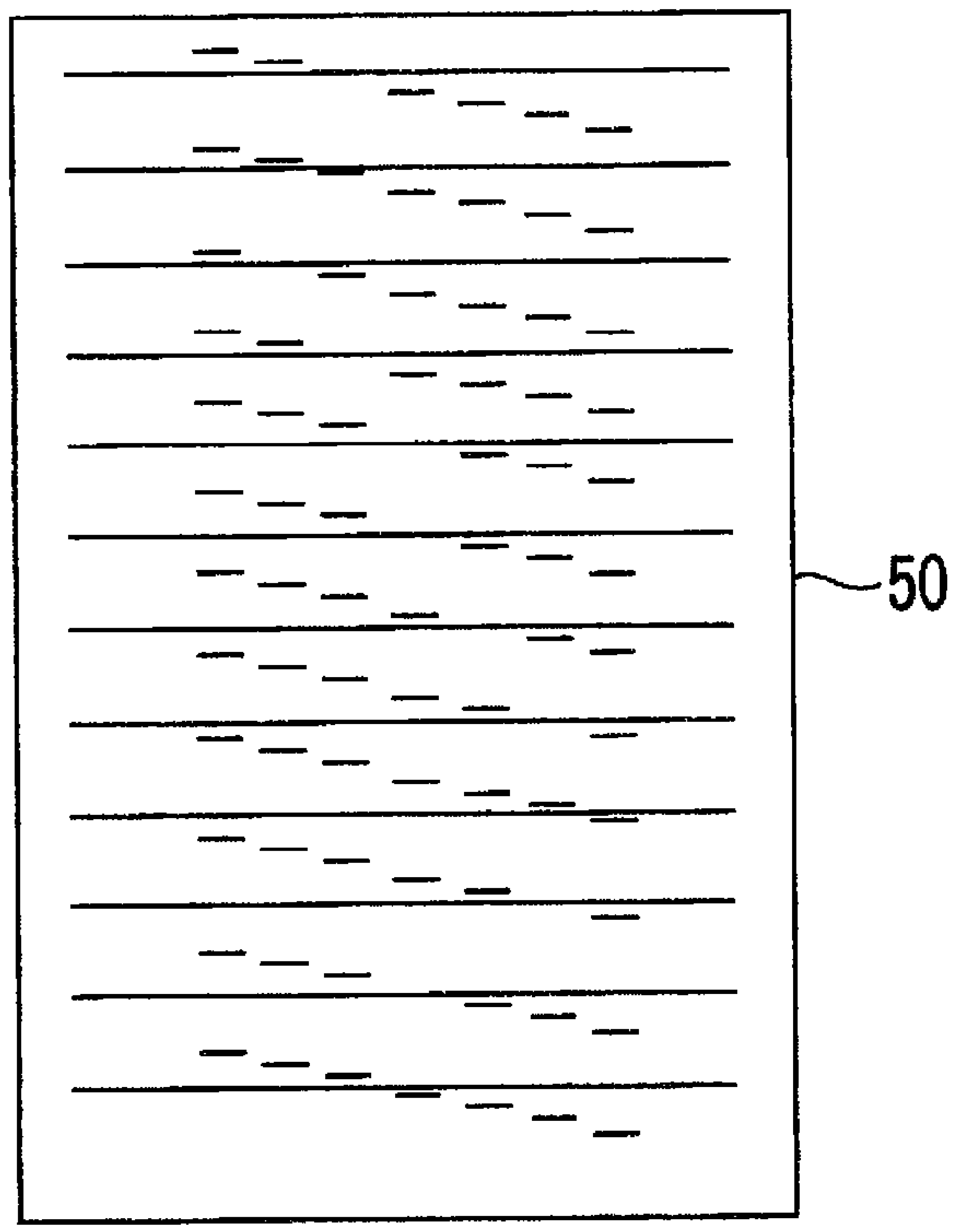


Fig. 11B

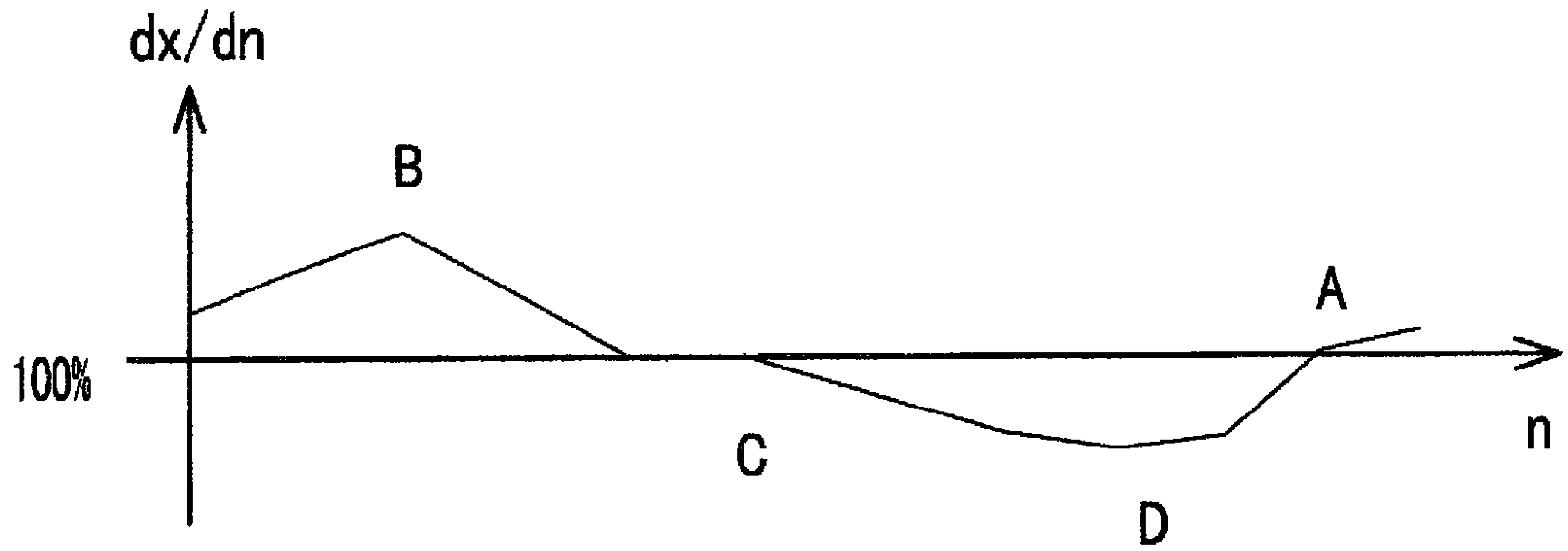


Fig. 12

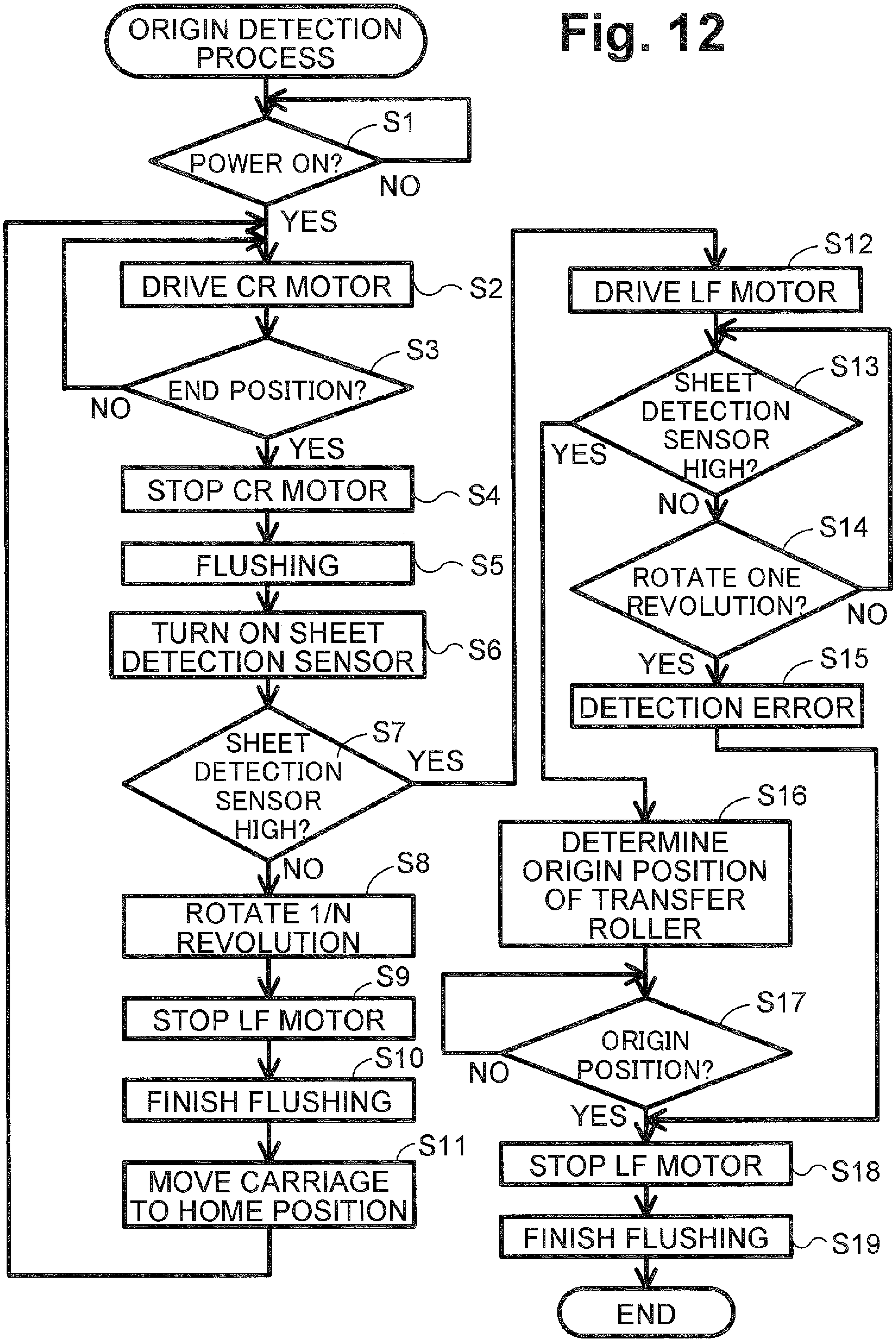

ORIGIN DETECTION PROCESS
S1
POWER ON?
NO
YES
DRIVE CR MOTOR
S2
S3
END POSITION?
NO
YES
STOP CR MOTOR
S4
FLUSHING
S5
TURN ON SHEET DETECTION SENSOR
S6
S7
SHEET DETECTION SENSOR HIGH?
YES
NO
S8
ROTATE 1/N REVOLUTION
S9
STOP LF MOTOR
S10
FINISH FLUSHING
S11
MOVE CARRIAGE TO HOME POSITION
S12
DRIVE LF MOTOR
S13
SHEET DETECTION SENSOR HIGH?
YES
NO
S14
ROTATE ONE REVOLUTION?
NO
YES
S15
DETECTION ERROR
S16
DETERMINE ORIGIN POSITION OF TRANSFER ROLLER
S17
ORIGIN POSITION?
NO
YES
STOP LF MOTOR
S18
FINISH FLUSHING
S19
END

Fig. 13

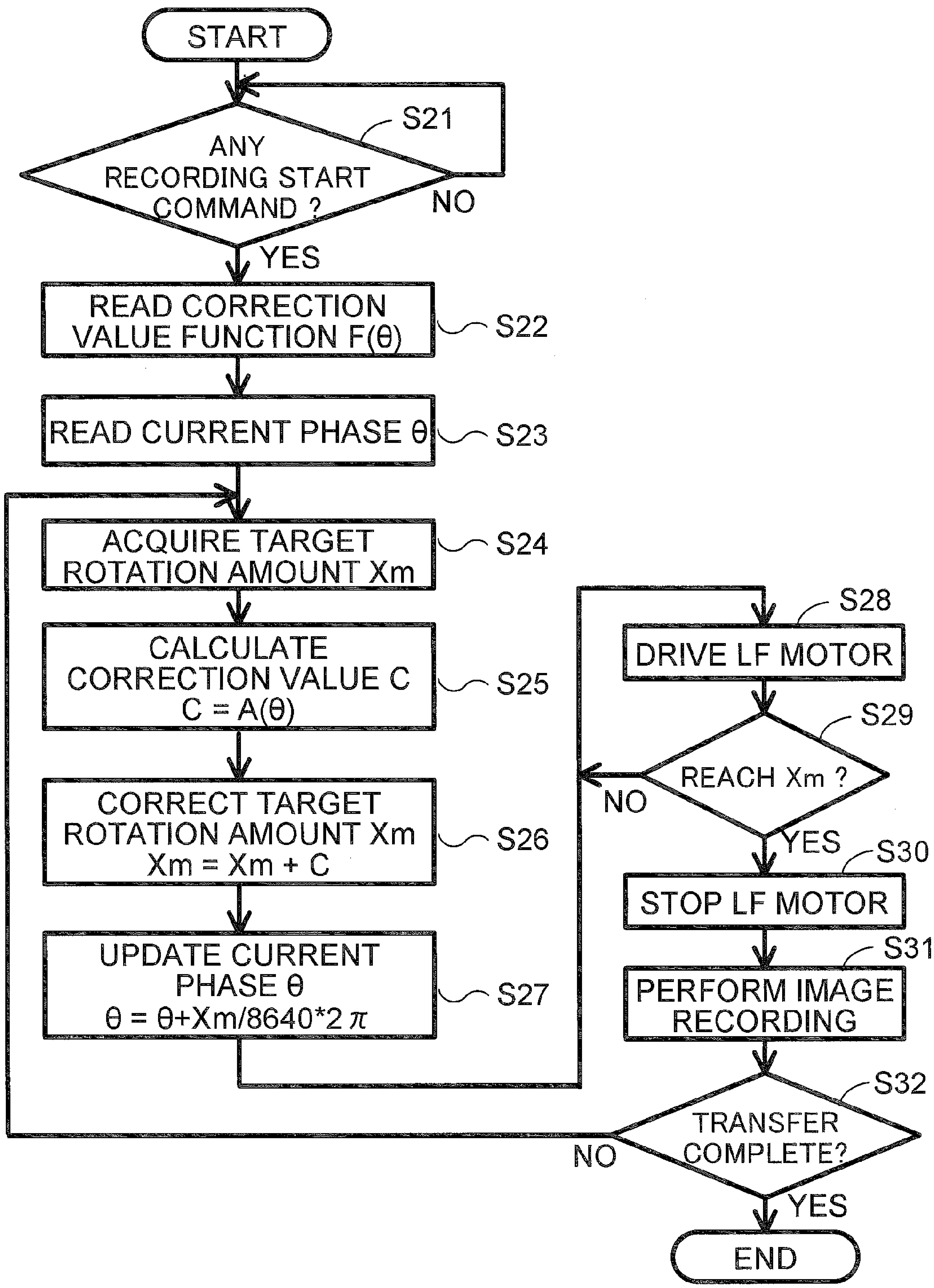

START
ANY RECORDING START COMMAND ?
S21
NO
YES
READ CORRECTION VALUE FUNCTION F(θ)
S22
READ CURRENT PHASE θ
S23
ACQUIRE TARGET ROTATION AMOUNT Xm
S24
CALCULATE CORRECTION VALUE C
C = A(θ)
S25
CORRECT TARGET ROTATION AMOUNT Xm
Xm = Xm + C
S26
UPDATE CURRENT PHASE θ
θ = θ+Xm/8640*2π
S27
S28
DRIVE LF MOTOR
S29
REACH Xm ?
NO
YES
S30
STOP LF MOTOR
S31
PERFORM IMAGE RECORDING
S32
TRANSFER COMPLETE?
NO
YES
END

Fig. 14A

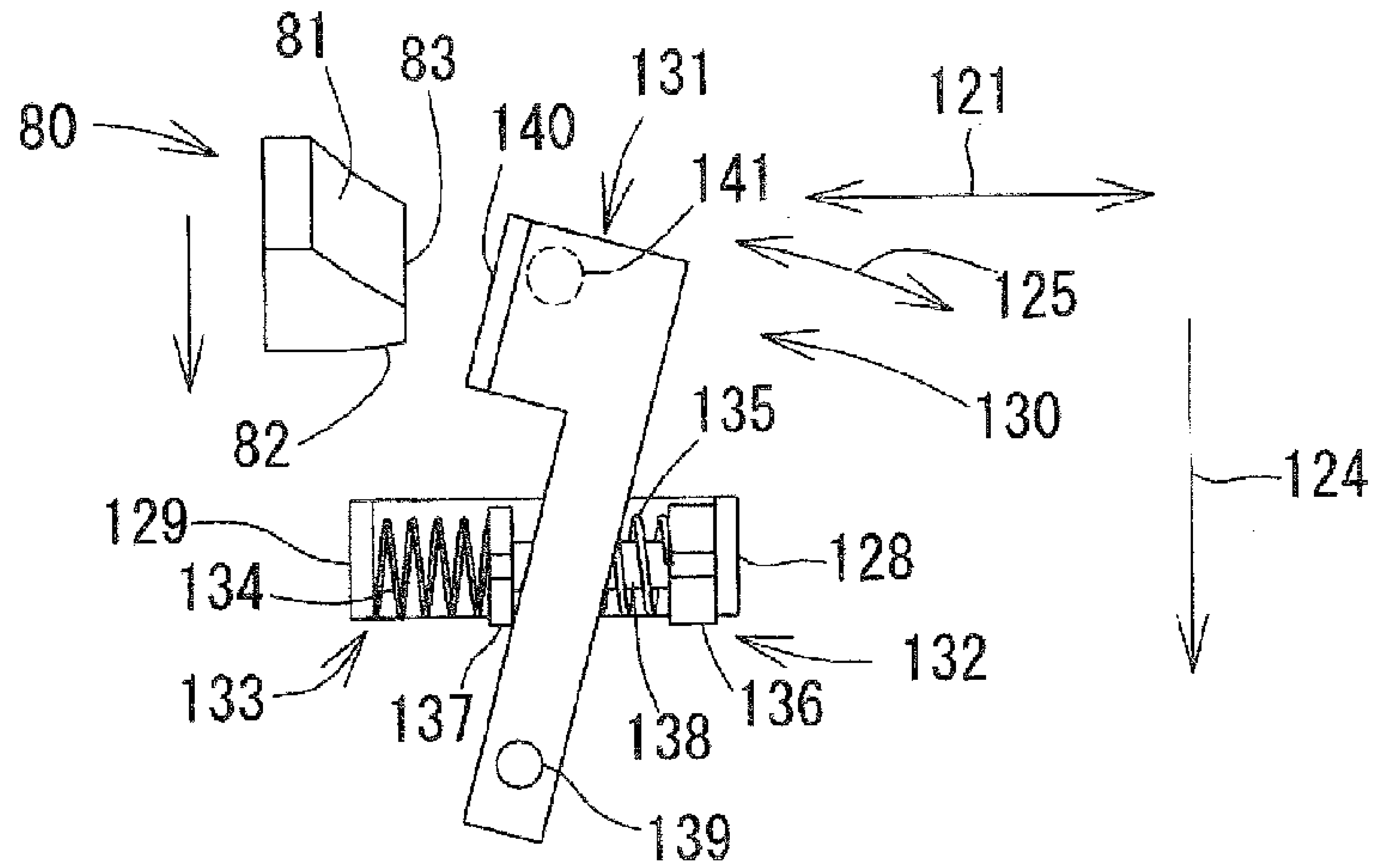


Fig. 14B

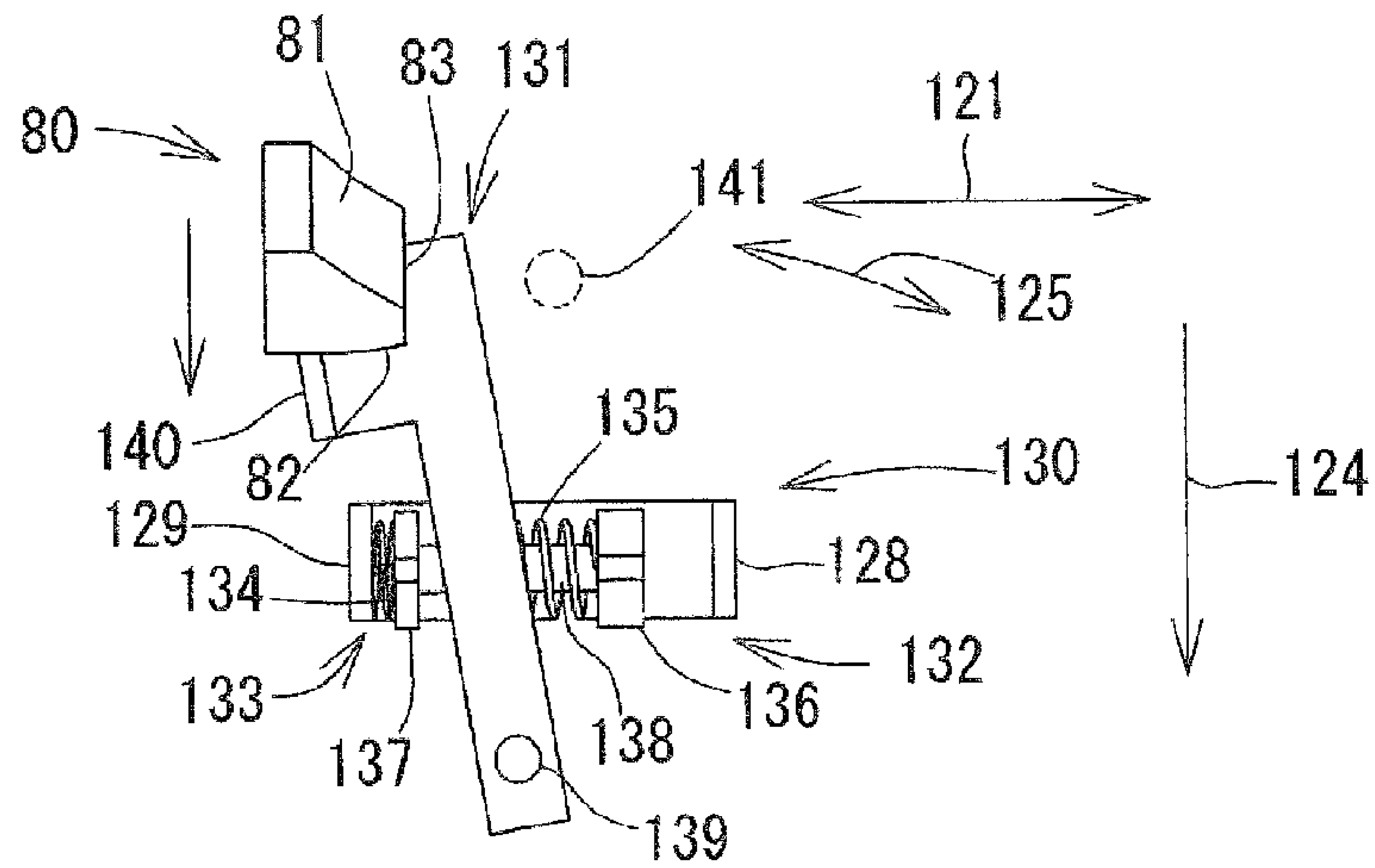


Fig. 14C

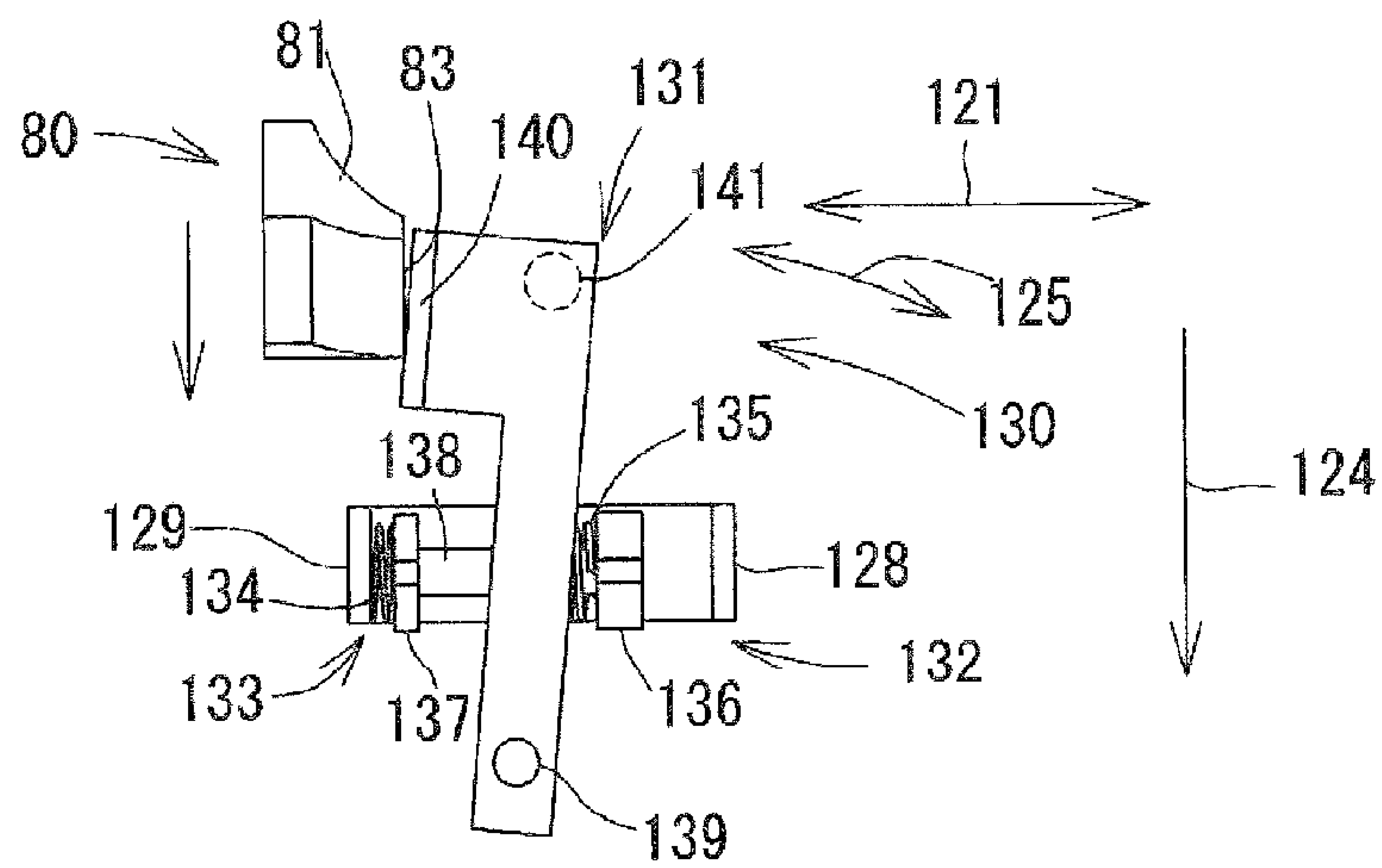
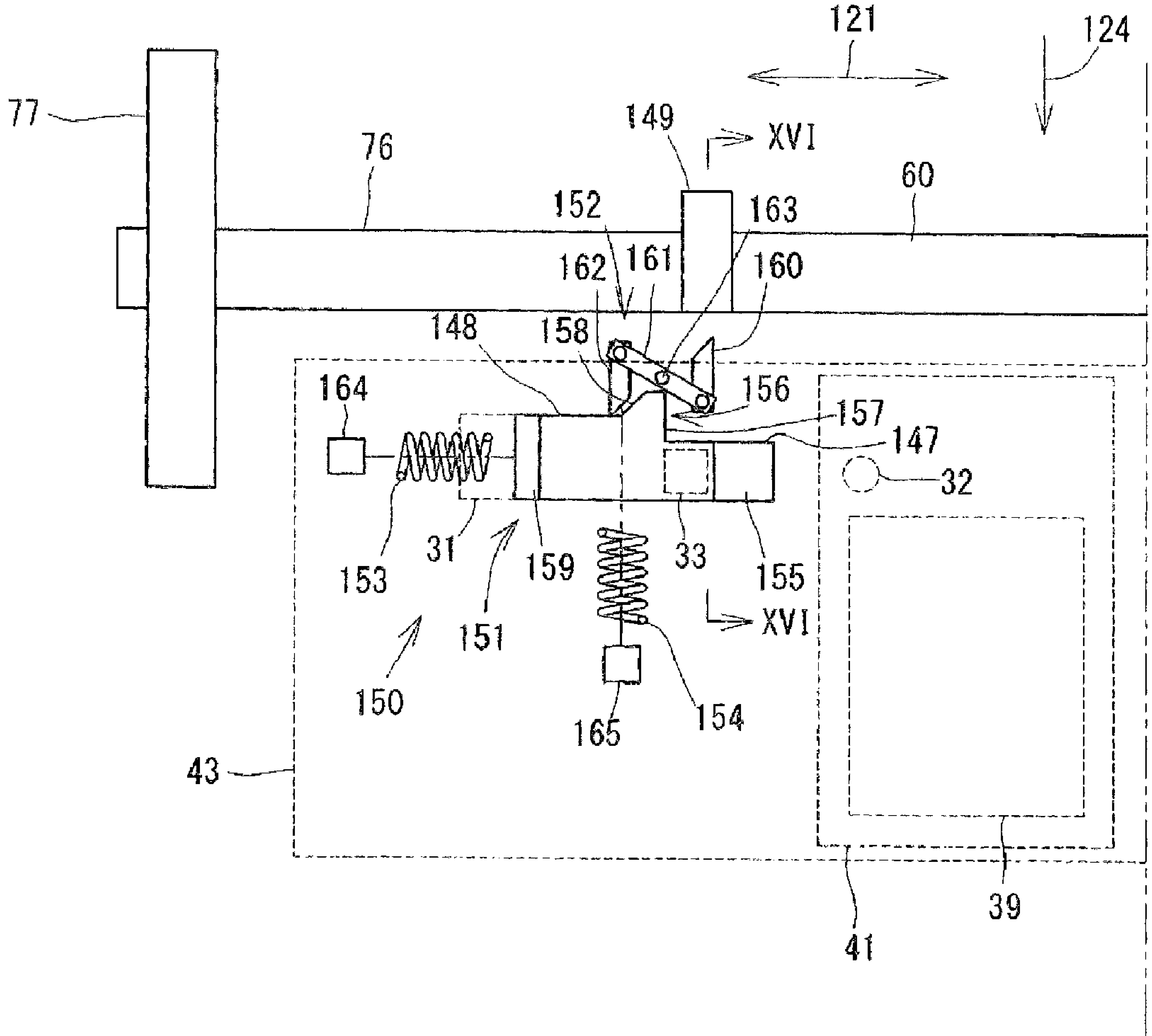


Fig. 15



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XVI
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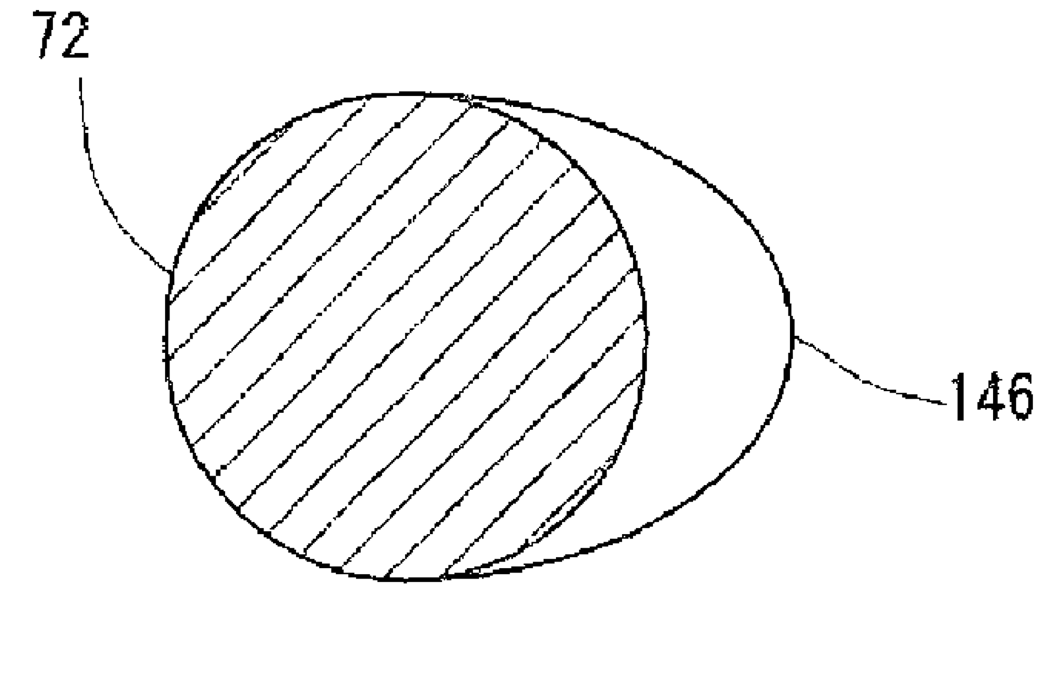
Fig. 16



72
146

Fig. 17

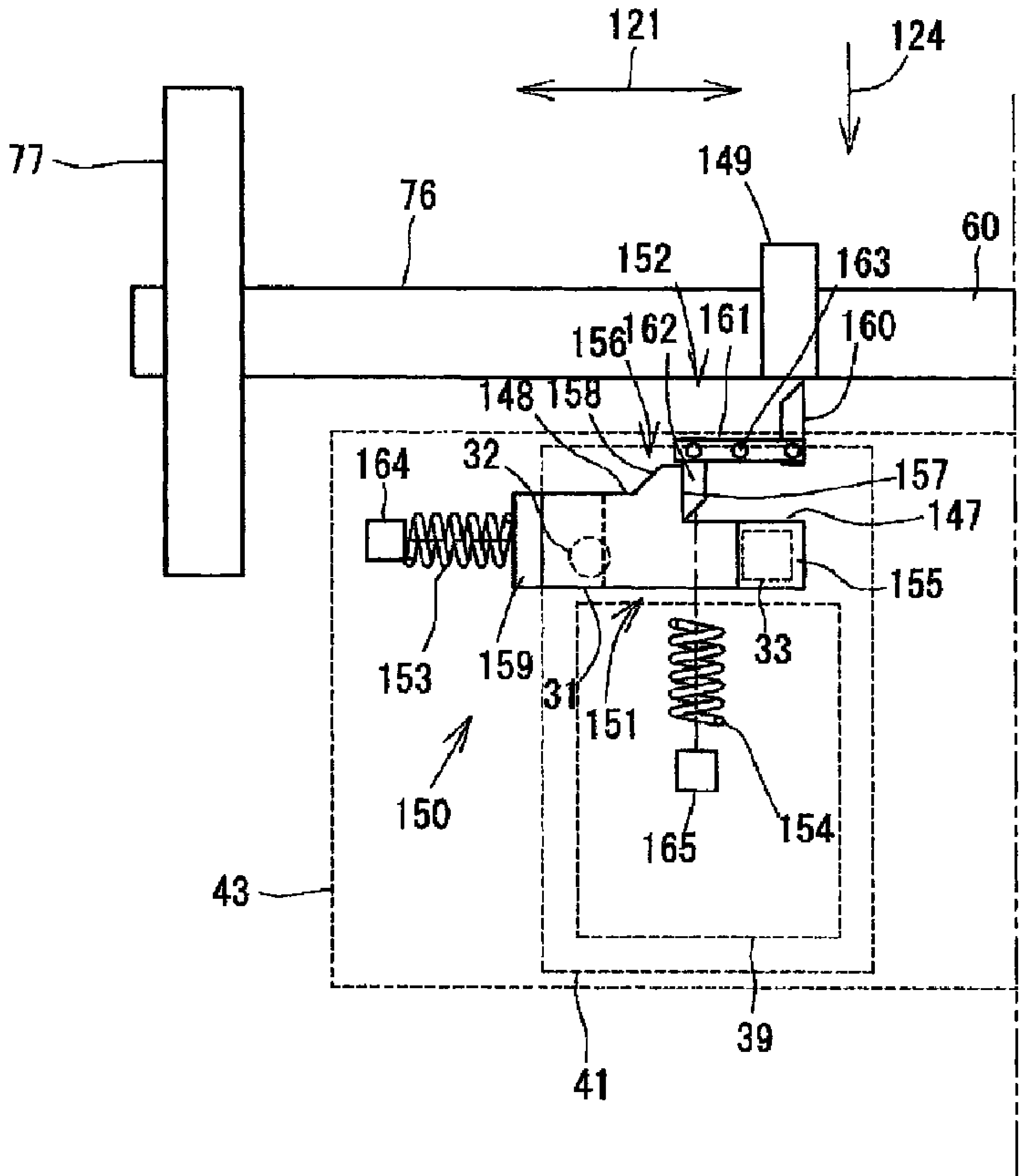

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Fig. 18

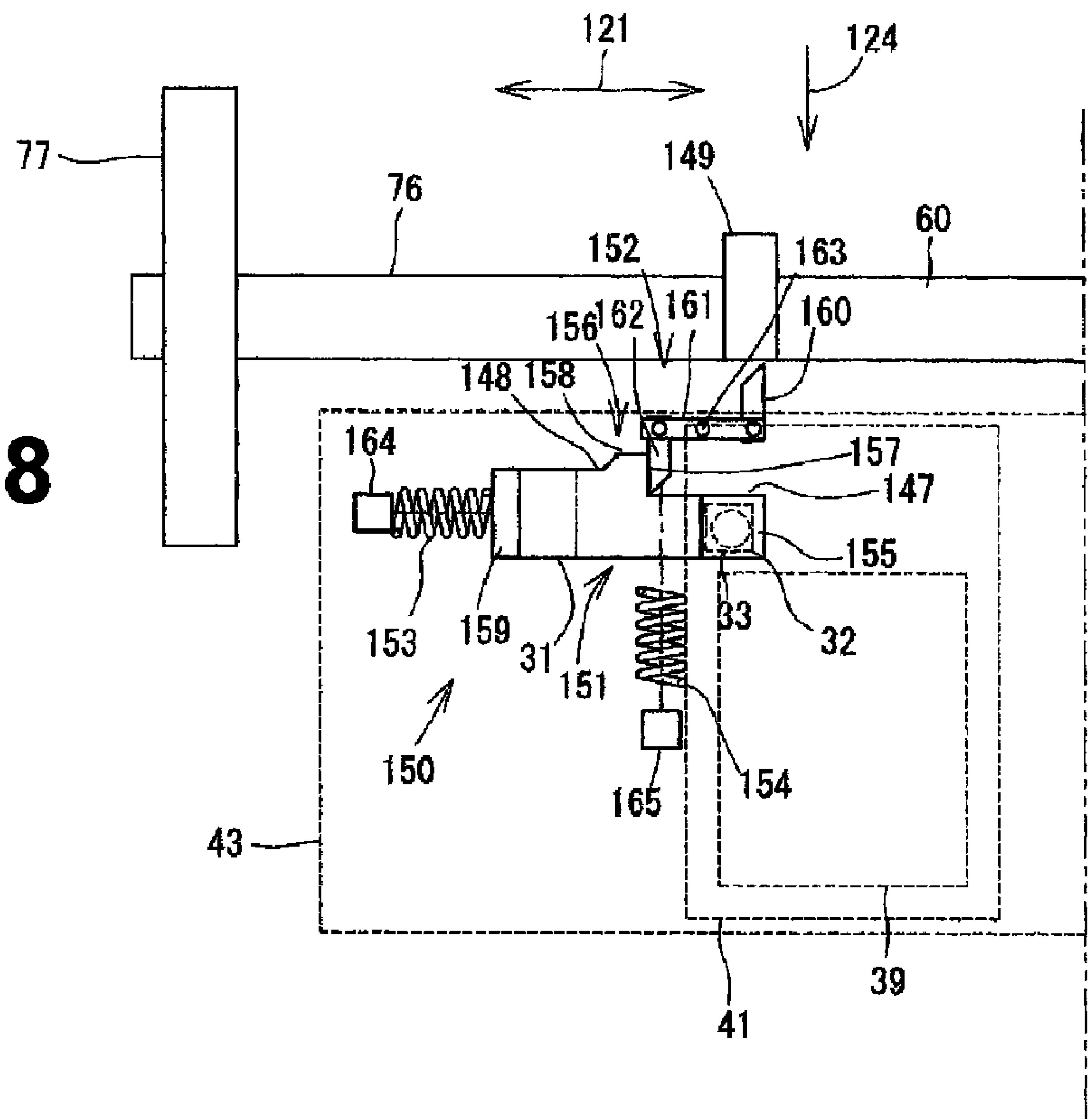
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Fig. 19

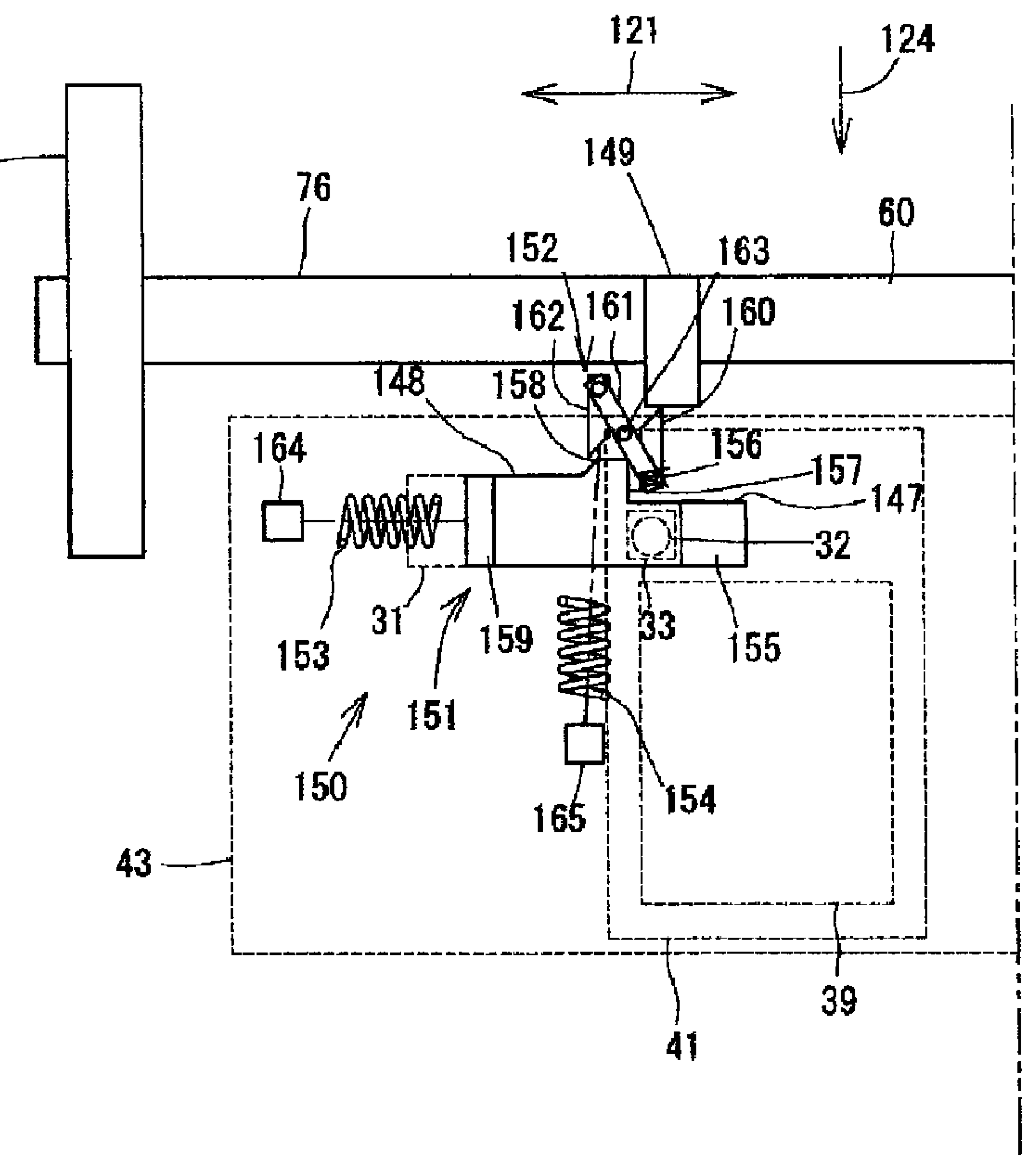
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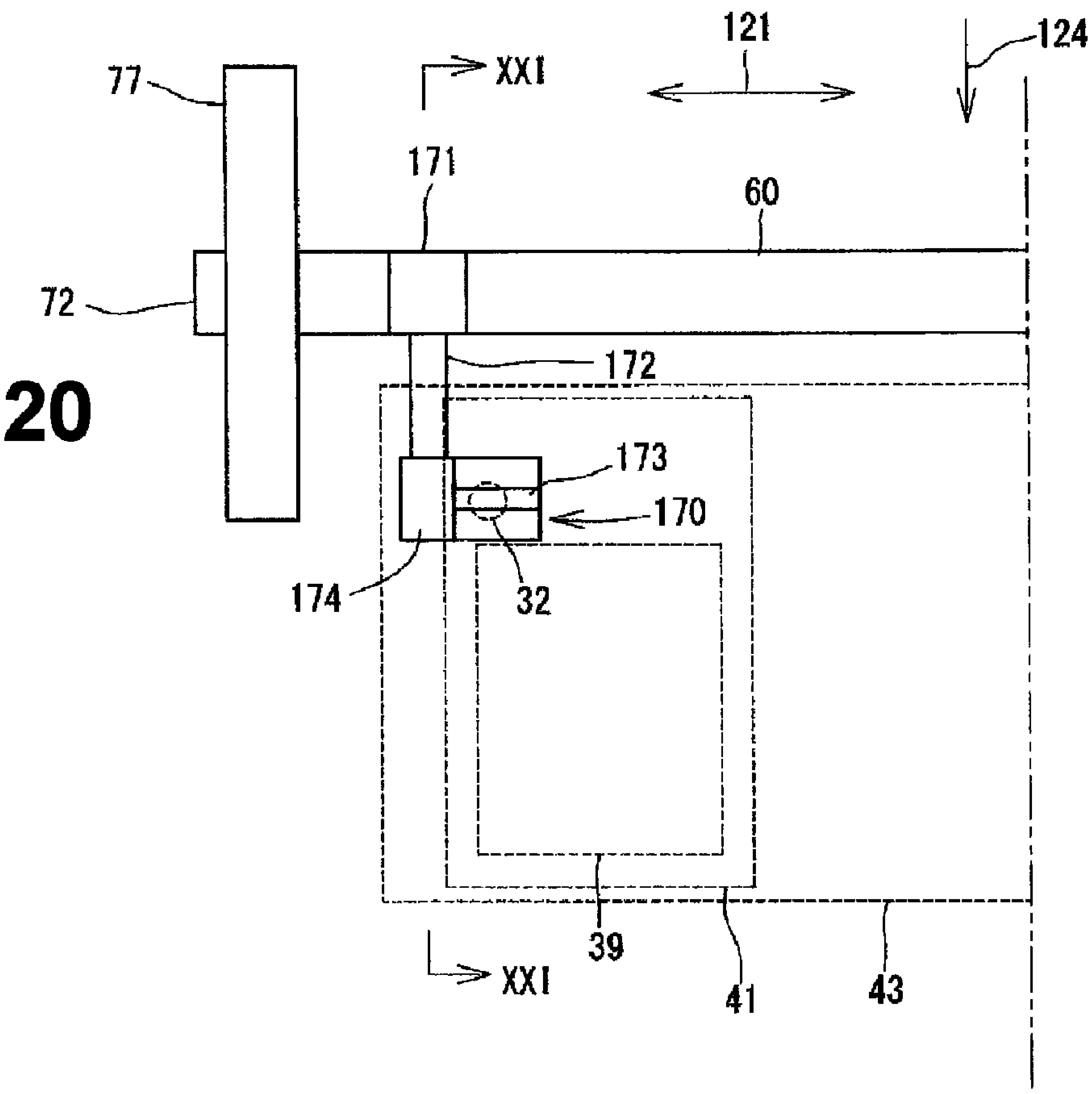
Fig. 20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XXI
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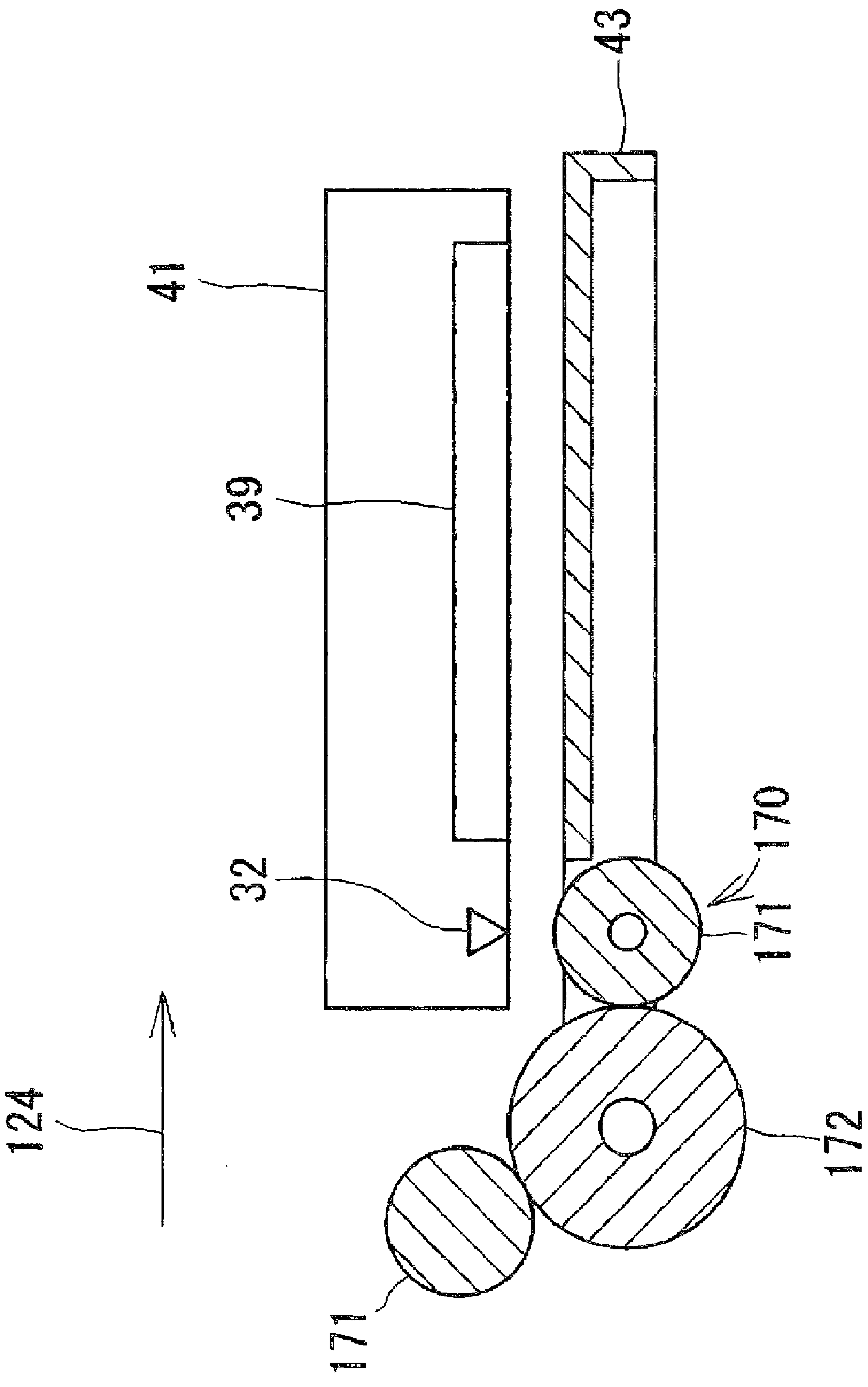

Fig. 21

IMAGE PRINTING DEVICE

CROSS REFERENCE TO RELATED APPLICATION

The present application claims priority from Japanese Patent Application No. 2009-201005, filed on Aug. 31, 2009, the disclosure of which is incorporated herein by reference in its entirety.

BACKGROUND

1. Technical Field

The present invention relates to an image printing device that determines the position of an origin of a transfer roller.

2. Related Art

An image printing device performs image printing by transferring a printing medium such as printing paper. A transfer roller is known as means for transferring the printing medium. The transfer roller is operated to transfer the printing medium by being rotated with contacting the printing medium. For implementation of high-quality image printing, the printing medium should be transferred with good accuracy. In consideration thereof, there is a technology known for correcting the rotation amount of a transfer roller in accordance with the position of the origin detected by using a sensor independently provided for detecting the position of the origin of the transfer roller.

SUMMARY

However, providing the sensor independently for detecting the position of the origin of the transfer roller may increase the device size or the cost. A need has arisen to provide an image printing device that determines the position of the origin of the transfer roller with a reduced device size or cost.

According to an embodiment of the invention, an image printing device comprises a transfer roller configured to transfer a printing medium in a transfer direction and a driving source which rotates the transfer roller. The image printing device further comprises a first sensor configured to detect a rotation amount of the transfer roller and a printhead which performs image printing onto the printing medium transferred by the transfer roller. The image printing device still further comprises a carriage configured to move in a movement direction intersecting the transfer direction. The carriage is mounted with the printhead. Moreover, the image printing device comprises a second sensor mounted to the carriage. The second sensor is configured to detect the printing medium. The image printing device further comprises a reference member disposed at a position opposing to the second sensor and a drive transmission mechanism configured to move the reference member in conjunction with a rotation of the transfer roller. The image printing device still further comprises a controller configured to control the driving source, the printhead, and the carriage. The controller is configured to move the carriage to a detection position where the second sensor detects the reference member, to drive the driving source to move the reference member via the drive transmission mechanism, and to determine the position of the origin of the transfer roller based on a detection result of the first sensor and a detection result of the second sensor.

BRIEF DESCRIPTION OF THE DRAWINGS

For a more complete understanding of the present invention, the needs satisfied thereby, and the features and advantages thereof, reference now is made to the following descriptions taken in connection with the accompanying drawings wherein:

FIG. **1** is a perspective view of a multifunctional device, showing the configuration thereof viewed from the outside;

FIG. **2** is a schematic view of a printer section, showing the internal configuration thereof;

FIG. **3** is a partial plan view of the printer section, showing the internal configuration thereof;

FIG. **4** is a partial perspective view of the printer section, showing the internal configuration thereof;

FIG. **5** is a partial perspective view of a transmission gear and therearound, showing the configuration thereof;

FIG. **6** is an enlarged perspective view of the transmission gear and therearound, showing the configuration thereof;

FIGS. **7**A to **7**C are each a plan view of a reference member, showing the configuration thereof;

FIG. **8** is a block diagram showing the configuration of a control section;

FIGS. **9**A and **9**B are each a diagram for illustrating the cyclic variation observed in the transfer amount of a printing paper, and specifically, FIG. **9**A is a schematic view of an encoder disk and that of an optical sensor, and FIG. **9**B is a graph exemplarily showing the transfer amount of the printing paper per pulse signal coming from a rotary encoder;

FIGS. **10**A to **10**D are each a diagram for illustrating a process for acquisition of a correction value function $A(\theta)$;

FIGS. **11**A and **11**B are each another diagram for illustrating the process for acquisition of the correction value function $A(\theta)$;

FIG. **12** is an exemplary flowchart of a process procedure to be executed in the multifunctional device in response to when the multifunctional device is turned on;

FIG. **13** is an exemplary flowchart of a process procedure to be executed in the multifunctional device in response to when a printing start command is provided;

FIGS. **14**A to **14**C are each a plan view of a reference member in a first modified example, showing the configuration thereof;

FIG. **15** is a plan view of a reference mechanism in a second modified example, showing the configuration thereof;

FIG. **16** is a cross-sectional view of the reference mechanism of FIG. **15**, showing the cross-sectional configuration thereof cut along a line XVI-XVI;

FIG. **17** is a plan view for illustrating the operation of the reference mechanism;

FIG. **18** is another plan view for illustrating the operation of the reference mechanism;

FIG. **19** is still another plan view for illustrating the operation of the reference mechanism;

FIG. **20** is a plan view of a drum or others in a third modified example, showing the configurations thereof; and

FIG. **21** is a cross-sectional view of the drum or others, showing the cross-sectional configurations thereof cut along a line XXI-XXI.

DESCRIPTION OF PREFERRED EMBODIMENTS

Embodiments of the invention and their features and advantages may be understood by referring to FIGS. **1-21**, like numerals being used for like corresponding parts in the various drawings. In the description given below, an entire configuration of a color printer as an example of an image forming apparatus in brief first, and then characteristic portions of the invention will be described in detail.

Schematic Configuration of Multifunctional Device **10**

As shown in FIG. **1**, a multifunctional device **10** is configured to include integrally a printer section **11** and a scanner section **12**, and provides various functions, i.e., printing, scanning, copying, and faxing. Note here that the multifunctional device **10** is an example of a image printing device and is not necessarily to include the scanning section **12**. An alternative image printing device may be implemented as a single-function printer, i.e., printer without the functions of scanning and copying. As such, no detailed description is given here about the configuration of the scanner section **12**.

In the multifunctional device **10**, the printer section **11** is disposed on the lower side. The printer section **11** is formed with an aperture **13** on the front side thereof. The printer section **11** is attached with sheet feeding cassettes **21** and **22** via the aperture **13**. The sheet feeding cassettes **21** and **22** are respectively provided thereon with a standard-sized rectangular printing paper(s) **50** (shown in FIG. **2**). In the printer section **11**, the printing paper **50** is directed selectively from either the sheet feeding cassette **21** or **22** into the printer section **11**. This printing paper **50** is ejected onto an upper surface **23** of the sheet feeding cassette **22** after printing of an image by a printing section **40** (shown in FIG. **2**). The upper surface **23** serves as a sheet ejection tray. The printing paper **50** is an example of the printing medium.

The multifunctional device **10** is used while being connected mainly to an external information device (not shown) such as computer. The printer section **11** is operated for image printing onto the printing paper **50** based on printing data provided by the external information device, and/or image data of a document read by the scanner section **12**.

The multifunctional device **10** is provided with an operation panel **14** on the upper front portion thereof. The operation panel **14** is provided with a display for display of various types of information, and input keys for input of information. The multifunctional device **10** is operated based on command information provided from the operation panel **14**, or command information coming from the external information device via a printer driver, a scanner driver, or others.

Printer Section **11**

In the below, by referring to FIGS. **2** to **7**C as appropriate, the configuration of the printer section **11** is described.

As shown in FIG. **2**, the sheet feeding cassettes **21** and **22** are disposed one on the other with the sheet feeding cassette **22** located on the upper side. The sheet feeding cassettes **21** and **22** are both provided for storing therein the printing paper **50** for image printing. With these two sheet feeding cassettes **21** and **22** provided separately as such, the printing paper **50** varying in size and type can be stored.

The sheet feeding cassette **21** is shaped like a case whose surface on the rear of the multifunctional device **10** is partially open, and carries a stack of the printing paper **50** in the internal space thereof. Such a sheet feeding cassette **21** is ready for storage of the printing paper **50** of various sizes equal to or smaller than the A3 size, e.g., the A4 size, the B5 size, and the card size.

The sheet feeding cassette **22** is shaped like a case whose surface on the rear of the multifunctional device **10**, i.e., on the right side in FIG. **2**, is partially open, and carries a stack of the printing paper **50** in the internal space thereof. Such a sheet feeding cassette **22** is ready for storage of the printing paper **50** of various sizes equal to or smaller than the A3 size, e.g., the A4 size, the B5 size, and the card size. The upper surface **23** of the sheet feeding cassette **22** is located on the front side of the multifunctional device **10**, i.e., on the left side in FIG. **2**.

First Supply Section **28**

The sheet feeding cassette **22** has an inclined plate **24**, which is provided thereon with a curved transfer path **18**. When the sheet feeding cassette **22** is attached to the printer section **11**, the inclined plate **24** is positioned below the transfer path **18**, and a first supply section **28** comes above the sheet feeding cassette **22**. The first supply section **28** is provided with a sheet feeding roller **25**, an arm **26**, and a shaft **27**. The sheet feeding roller **25** is provided at the tip end side of the arm **26** to be able to rotate. The arm **26** is provided, to be able to move circular, to the shaft **27** that is supported by the chassis of the printer section **11**. The arm **26** is biased to move circular to the side of the sheet feeding cassette **22** by the self weight or by the elastic force of a spring or others.

Second Supply Section **38**

The sheet feeding cassette **21** has an inclined plate **34**, which is provided thereon with a curved transfer path **17**. When the sheet feeding cassette **21** is attached to the printer section **11**, the inclined plate **34** is positioned below the transfer path **17**, and a second supply section **38** comes above the sheet feeding cassette **21**. The second supply section **38** is provided with a sheet feeding roller **35**, an arm **36**, and a shaft **37**. The sheet feeding roller **35** is provided at the tip end side of the arm **36** to be able to rotate. The arm **36** is provided, to be able to move circular, to the shaft **37** that is supported by the chassis of the printer section **11**. The arm **36** is biased to move circular to the side of the sheet feeding cassette **21** by the self weight or by the elastic force of a spring or others.

Transfer Paths **17**, **18**, and **19**

The printer section **11** is provided therein with a transfer path **19**, which is an extension of the transfer paths **17** and **18**. This transfer path **19** is provided for transfer of the printing paper **50** thereover coming along the transfer path **17** or **18**, and is extended all the way to above the upper surface **23** of the sheet feeding cassette **22** from the position where the transfer paths **17** and **18** are merged to the front side of the multifunctional device **10**.

Platen **43**

The transfer path **19** is provided with a platen **43** (shown in FIGS. **2** and **3**). The platen **43** serves to support from below the printing paper **50** coming along the transfer path **19**. This platen **43** is provided with the printing section **40** on the upper side thereof. This printing section **40** will be described later. The upper surface of the platen **43** is colored to have a reflectivity different from that of the printing paper **50**. The printing paper **50** is generally white, and thus the upper surface of the platen **43** is colored black, for example.

As shown in FIGS. **4** and **5**, a waste ink tray **66** (an example of an ink receiving section) is provided at one end of the platen **43** in a cross direction **121** and on the side of a transmission gear **77** that will be described later (shown in FIG. **3**). The waste ink tray **66** is provided for receiving ink drops bursting from a printhead **42** for maintenance purpose. The waste ink tray **66** is in the shape of a tray corresponding to the area of nozzles of the printhead **42**, and in its internal space, an ink absorber is filled. The ink absorber absorbs and keeps the ink drops burst from the printhead **42**. When any ink in the area of the nozzles is wiped out after purging, for example, there is a possibility of slight mixture of wrong ink at the respective nozzle ports, or abnormal meniscus of the ink at the respective nozzle ports. For prevention thereof, the ink drops are burst from all of the nozzle ports of the printhead **42** after purging, thereby ejecting any mixed ink or restoring the meniscus at the respective nozzle ports to the normal state. In this specification, such bursting motion of the ink drops is referred to as flushing.

Transfer Roller Pair **59**

A transfer roller pair **59** is provided on the upstream side than the platen **43** in a transfer direction **124** of the printing paper **50**. The transfer roller pair **59** is configured by a transfer roller **60** and a pinch roller **61**. The transfer roller **60** is disposed on the upper side of the transfer path **19**, and is rotated in response to the driving force coming from an LF motor **85** which is an example of a driving source (shown in FIG. **6**). The pinch roller **61** is disposed, to be able to freely rotate, on the lower side of the transfer roller **60** with the transfer path **19** sandwiched therebetween, and is biased by a spring toward the transfer roller **60**.

Sheet Ejection Roller Pair **64**

A sheet ejection roller pair **64** is provided on the downstream side than the platen **43** in the transfer direction **124** of the printing paper **50**. The sheet ejection roller pair **64** is configured by a sheet ejection roller **62** and a spur **63**. The sheet ejection roller **62** is disposed on the lower side of the transfer path **19**, and is rotated in response to the driving force coming from the LF motor **85** (shown in FIG. **6**). The spur **63** is disposed, to be able to freely rotate, on the upper side of the sheet ejection roller **62** with the transfer path **19** sandwiched therebetween, and is biased by a spring toward the sheet ejection roller **62**.

Encoder Disk **71**, and Optical Sensor **55**

As shown in FIGS. **3** to **6**, the transfer roller **60** is provided with an encoder disk **71** to a shaft **76** thereof. The encoder disk **71** is shaped like a transparent disk, and is marked at a predetermined pitch in the circumferential direction for light shielding. Such an encoding disk **71** is fixed to the shaft **76** of the transfer roller **60**, and rotates together with the transfer roller **60**. The optical sensor **55** is configured by light-emitting elements and light-receiving elements, which are disposed to oppose to one another at predetermined intervals in the cross direction **121**. The optical sensor **55** is so disposed that the peripheral edge of the encoder disk **71** is located in the space between the light-emitting elements and the light-receiving elements. When the light-receiving elements of the optical sensor **55** receive light, the optical sensor **55** generates an electric signal of the level corresponding to the intensity of the received light. In the state with a mark between the light-emitting elements and the light-receiving elements, the resulting electric signal will be of LOW level, and in the state with no mark therebetween, the resulting electric signal will be of HI level. That is, every time the optical sensor **55** detects a mark of the encoder disk **71**, a pulse signal is generated. Thus generated pulse signal is output to a control section **100**. With the encoder disk **71** and the optical sensor **55** as such, a first sensor is implemented.

Printing Section **40**

As shown in FIGS. **2** to **4**, the printing section **40** is disposed on the upper side of the platen **43** to oppose the platen **43** with a predetermined distance therefrom. That is, the printing section **40** is disposed on the downstream side than the transfer roller pair **59** in the transfer direction **124**. The printing section **40** is provided with the ink-jet printhead **42**, and a carriage **41**.

Carriage **41**

As shown in FIG. **4**, the carriage **41** is in the rectangular parallelepiped shape. This carriage **41** is mounted with the printhead **42**, and the printhead **42** is exposed to the lower surface side. The carriage **41** is configured to be able to move in the cross direction **121** along guide frames **44** and **45** that will be described later. In the carriage **41**, as for two side surfaces of the carriage **41** opposing to each other in the cross direction **121**, on the side surface opposing the transmission gear **77** (shown in FIG. **3**), an abutting section **53** is provided to project in the cross direction **121**. This abutting section **53** can come in contact with an object **91** (shown in FIGS. **7**A to **7**C) of a sensing member **90** (an example of a reference member) that will be described later.

Guide Frames **44** and **45**

As shown in FIGS. **3** and **4**, on the upper side of the transfer path **19**, a pair of guide frames **44** and **45** are disposed with a predetermined distance therebetween in the transfer direction **124**. These guide frames **44** and **45** are so disposed as to extend in the cross direction **121**. The guide frame **44** is provided on the upstream side than the guide frame **45** in the transfer direction **124**. The carriage **41** is provided to the guide frames **44** and **45** in such a manner as to lay thereacross. With such a configuration, the carriage **41** is opposing the platen **43** with the transfer path **19** sandwiched therebetween. Note that, in FIG. **2**, the guide frames **44** and **45** are not shown.

As for the carriage **41**, one end portion thereof on the upstream side in the transfer direction **124** is supported by the upper surface of the guide frame **44** to be able to freely slide. Also as for the carriage **41**, one end portion thereof on the downstream side in the transfer direction **124** is supported by the upper surface of the guide frame **45** to be able to freely slide. An end portion **39** of the guide frame **45** is formed by bending upward a part of the guide frame **45** in the direction of substantially right angles, and is extended in the cross direction **121**. Such an end portion **39** is pinched by the carriage **41** using a resin member with a high sliding characteristic or others that are not shown. This accordingly allows the carriage **41** to move in the cross direction **121** relative to the end portion **39**.

Belt Drive Mechanism **46**

As shown in FIGS. **3** and **4**, a belt drive mechanism **46** is disposed on the upper surface of the guide frame **45**. This belt drive mechanism **46** is configured by a drive pulley **47**, a follower pulley **48**, and a belt **49**. The drive pulley **47** and the follower pulley **48** are respectively provided in the vicinity of the ends of the belt drive mechanism **46** in the cross direction **121**. The belt **49** is shaped like an endless ring with teeth provided inside, and is placed across the drive pulley **47** and the follower pulley **48**.

The shaft of the drive pulley **47** is connected with a CR motor **86** (shown in FIG. **4**). The drive pulley **47** rotates in response to the driving force of the CR motor **86**. The rotation force of this drive pulley **47** moves the belt **49** to circulate. As is fixed to this belt **49**, the carriage **41** is moved in the cross direction **121** in response to the circular movement of the belt **49**.

Encoder Strip **51**, and Optical Sensor **52**

As shown in FIGS. **3** and **4**, the guide frame **45** is provided with an encoder strip **51**. The encoder strip **51** is placed across the movement range of the carriage **41** in the cross direction **121**. The encoder strip **51** is shaped like a band made of transparent resin. The encoder strip **51** is marked with a pattern in which a light shielding section for light shielding and a light transmission section for light transmission are arranged alternately at a constant pitch. The carriage **41** is mounted with an optical sensor **52** for detection of such a pattern of the encoder strip **51**.

The optical sensor **52** is configured by light-emitting elements and light-receiving elements, which are disposed to oppose to one another with a predetermined distance therebetween in a depth direction **123**. The optical sensor **52** is so disposed that the encoder strip **51** is located in the space between the light-emitting elements and the light-receiving elements. When the light-receiving elements of the optical sensor **52** receive light, the optical sensor **52** generates an electric signal of the level corresponding to the intensity of the received light. In the state with a mark between the light-emitting elements and the light-receiving elements, the resulting electric signal will be of LOW level, and in the state with no mark therebetween, the resulting electric signal will be of HI level. That is, every time the optical sensor **52** detects a mark of the encoder strip **51**, a pulse signal is generated. Thus generated pulse signal is output to the control section **100**.

Printhead **42**

As shown in FIGS. **2** and **4**, as for the printhead **42**, a nozzle section is exposed from the lower surface of the carriage **41**. The nozzle section includes a large number of nozzles, which are arranged both in the cross and depth directions **121** and **123**. Such a printhead **42** is provided with a supply of ink from an ink cartridge (not shown) provided inside of the printer section **11**. Every time the printing paper **50** stops moving on the platen **43** due to the intermittent movement of the transfer roller **60** and the sheet ejection roller **62**, the carriage **41** is moved in the cross direction **121**. Together with the carriage **41** moving as such, the printhead **42** is also moved in the cross direction, and during such a movement, very small ink drops are burst selectively from the nozzles of the printhead **42** toward the printing paper **50** on the platen **43**. Thereafter, by the transfer roller pair **59** and the sheet ejection roller pair **64**, the printing paper **50** is transferred in the transfer direction **124** by the amount equal to a predetermined line-feed width. By alternately repeating such intermittent transfer of the printing paper **50** and the movement of the carriage **41**, the printhead **42** performs image printing on the printing paper **50**.

As shown in FIG. **2**, the carriage **41** is provided with a sheet detection sensor **32** (an example of a second sensor). The sheet detection sensor **32** is exposed from the lower surface of the carriage **41**, and is disposed on the upstream side than the printhead **42** in the transfer direction **124**. The sheet detection sensor **32** is an optical sensor of a reflective type. Although not shown in detail in FIG. **2**, the sheet detection sensor **32** is provided with light-emitting elements and light-receiving elements. From these light-emitting elements, light is directed downward in a height direction **122**, and the light-receiving elements receive the reflected light coming from the height direction **122** of the sheet detection sensor **32**. The sheet detection sensor **32** then outputs an electric signal corresponding to the light-receiving level of the light-receiving elements. It means that the sheet detection sensor **32** outputs an electric signal corresponding to the intensity of the reflective light under the illumination light of a fixed level of intensity, i.e., an electric signal corresponding to the reflectivity of an area opposing the sheet detection sensor **32**. This reflectivity corresponds to a physical quantity, and the sheet detection sensor **32** corresponds to a second sensor.

LF Motor **85**

As shown in FIG. **6**, the printer section **11** is provided with the LF motor **85**. The LF motor **85** serves to rotate the transfer roller **60** and the sheet ejection roller **62** with rotation control thereover. Such an LF motor **85** is exemplified by a DC (Direct-Current) motor. This LF motor **85** corresponds to a driving source.

In the LF motor **85**, an output shaft **75** is formed with dents on the outer periphery thereof, and is engaged with the transmission gear **77**. The transmission gear **77** is a spur gear, and is coaxially coupled to the shaft **76** of the transfer roller **60**, thereby rotating in conjunction with the shaft **76**. With such a transfer gear **77**, the rotation of the LF motor **85** is transmitted to the shaft **76** of the transfer roller **60**. This transmission gear **77** corresponds to a drive transmission mechanism.

The transmission gear **77** is being engaged with a transmission gear **78**. This transmission gear **78** is also coupled with another transmission gear (not shown) in series, and is eventually coupled to the shaft of the sheet ejection roller **62**. The rotation of the LF motor **85** is transmitted also to the shaft of the sheet ejection roller **62** so that the transfer roller **60** and the sheet ejection roller **62** rotate in conjunction with each other.

The transfer roller **60** and the sheet ejection roller **62** are driven intermittently by the LF motor **85** at the time of image printing by the printing section **40**. The expression of "driven intermittently" herein means a driving mode with which the LF motor **85** is repeatedly driven and stopped, i.e., the LF motor **85** is continuously driven until the transfer roller **60** and the sheet ejection roller **62** are rotated by the rotation amount corresponding to a predetermined target transfer amount, and when the rollers are rotated by the target transfer amount, the LF motor **85** is then stopped for a predetermined length of time.

When the printing paper **50** provided to the transfer path **19** reaches the area between the transfer roller **60** and the pinch roller **61**, the printing paper **50** is directed onto the platen **43** by the rotation force of the transfer roller **60** while being sandwiched between the transfer roller **60** and the pinch roller **61**. When such a printing paper **50** then reaches the area between the sheet ejection roller **62** and the spur **63**, the printing paper **50** is directed above the sheet feeding cassette **22** by the rotation force of the sheet ejection roller **62** while being sandwiched between the sheet ejection roller **62** and the spur **63**.

As such, the printing paper **50** is transferred over the platen **43** by the rotation force of at least either the transfer roller **60** or the sheet ejection roller **62**. During the transfer as such, because the transfer roller **60** and the sheet ejection roller **62** are driven intermittently, the printing paper **50** is transferred also intermittently along the transfer path **19**. Thereafter, when the printing paper **50** is stopped moving on the platen **43** during such intermittent transfer, the printing section **40** performs image printing thereon.

Note here that when the printing section **40** does not perform image printing, there is no need for the transfer roller **60** and the sheet ejection roller **62** to be driven intermittently. Accordingly, before the printhead **42** starts to operate for image printing, and after the completion of the printing operation, the transfer roller **60** and the sheet ejection roller **62** are rotated in sequence.

Transmission Gear **77**

As shown in FIGS. **5** and **6**, in the transmission gear **77**, a surface **79** facing the side of the carriage **41** is provided with a protrusion **80**. This protrusion **80** is placed in a predetermined rotation phase of the transmission gear **77**, and projects from the surface **79** in the cross direction **121** being the movement direction of the carriage **41**. The protrusion **80** is configured to include inclined surfaces **81** and **82**, and a surface **83**. The inclined surfaces **81** and **82** each form a predetermined inclined angle with respect to the surface **79**, and the surface **83** is disposed between the inclined surfaces **81** and **82** to be parallel to the surface **79**. These inclined surfaces **81** and **82** are those inclined substantially along the circumferential direction of the transmission gear **77**.

Sensing Member **90**

As shown in FIG. **5**, the sensing member **90** (an example of reference member) is disposed in the vicinity of an end portion of the platen **43** where the transmission gear **77** is disposed thereon. This sensing member **90** is operated by the protrusion **80** provided to the transmission gear **77**.

As shown in FIGS. **7**A to **7**C, the sensing member **90** is configured mainly by the object **91**, a lever **92**, a supporting member **93**, and coil springs **94** and **95**. The supporting member **93** is fixed on the upper surface of the platen **43**. Such a supporting member **93** is incorporated with the object **91** and the lever **92** to be able to slide in the cross direction **121**. The supporting member **93** is provided with walls **111** and **112**, which are disposed with a distance therebetween in the cross direction **121**. The object **91** and the lever **92** are allowed to slide in the cross direction **121** as such between the walls **111** and **112**.

The lever **92** is configured by first and second abutting pieces **96** and **97**, which are coupled together by a shaft **98**. The first and second abutting pieces **96** and **97** are disposed with a distance therebetween in the cross direction **121**, and the shaft **98** extends along the cross direction **121**. This shaft **98** is coupled with, at its both ends, the first and second abutting pieces **96** and **97**, respectively. The first and second abutting pieces **96** and **97** are so disposed that the second abutting piece **97** is located on the side of the transmission gear **77**. In a range where the lever **92** is moved to slide in the cross direction **121**, the first abutting piece **96** is allowed to come in contact with the wall **111** of the supporting member **93**. The position where the first abutting piece **96** comes in contact with the wall **111** of the supporting member **93** as such is the end of the range where the first abutting piece **96** is allowed to slide toward the center in the cross direction **121**, i.e., on the right side in FIGS. **3** and **7**A to **7**C. Between the second abutting piece **97** and the wall **112** of the supporting member **93**, the coil spring **94** is provided. The second abutting piece **97** and the wall **112** each serve as a spring seat of the coil spring **94**. The coil spring **94** is disposed between the second abutting piece **97** and the wall **112** of the supporting member **93**, and is compressed therebetween. By such a coil spring **94**, the lever **92** is biased toward the center in the cross direction **121**.

The object **91** is incorporated to the shaft **98** of the lever **92**, thereby being allowed to slide in the cross direction **121**. More in detail, the object **91** is configured to include a supporting section **113** and a detecting portion **114**, and is shaped like a letter T in a planar view. The supporting section **113** is provided to the shaft **98** to be able to freely slide, and the detecting portion **114** is extended from the supporting section **113** in the cross direction **121**. The supporting section **113** is formed with a through hole (not shown) that goes through in a thickness direction, i.e., cross direction **121**. Through this through hole, the shaft **98** is inserted so that the supporting section **113** is incorporated to the shaft **98** to be able to freely slide. The supporting section **113** is projected from the shaft **98** in the diameter direction, and is shaped like a flat plate extending along the transfer and height directions **124** and **122**.

The supporting section **113** is coupled with the detecting portion **114** at the extended end thereof. The detecting portion **114** is projected from the extended end of the supporting section **113** toward the both sides in the cross direction **121**, and is shaped like a flat plate extending in both the cross and height directions **121** and **122**. The detecting portion **114** is so configured as to have a reflectivity different from that of the upper surface of the platen **43**. This is for the detecting portion **114** to output an electric signal of varying level between when the sheet detection sensor **32** is opposing the detecting portion **114**, and when it is opposing the upper surface of the platen **43**. Such a difference of reflectivity is implemented by a different surface roughness between the detecting portion **114** and the upper surface of the platen **43**, a different face angle therebetween, a different surface material therebetween, or others. In this embodiment, such a difference of reflectivity is achieved by different coloring between the detecting portion **114** and the upper surface of the platen **43**. More specifically, the upper surface of the platen **43** is colored black, and the detecting portion **114** is colored white.

The coil spring **95** is disposed between the first abutting piece **96** of the lever **92** and the supporting section **113** of the object **91**. This coil spring **95** is externally wound around the shaft **98**. The first abutting piece **96** and the supporting section **113** each serve as a spring seat of the coil spring **95**. The coil spring **95** is disposed between the first abutting piece **96** and the supporting section **113**, and is compressed. By such a coil spring **95**, the object **91** is biased toward the outside in the cross direction **121**, i.e., on the side of the transmission gear **77**: on the left side in FIGS. **3** and **7**A to **7**C.

As shown in FIG. **7**A, when the sensing member **90** is free from any external force, the lever **92** is moved to slide toward the center in the cross direction **121** by being biased by the coil spring **94** so that the first abutting piece **96** comes in contact with the wall **111** of the supporting member **93**. Moreover, the object **91** is moved to slide toward the outside in the cross direction **121** by being biased by the coil spring **95** so that the supporting section **113** comes in contact with the second abutting piece **97** of the lever **92**. Also in this state, between the detecting portion **114** of the object **91** and the first abutting piece **96** of the lever **92**, a space **115** is formed.

As shown in FIG. **7**B, when the carriage **41** is moved to the end position, i.e., the position shown in FIG. **3**, the abutting section **53** of the carriage **41** comes in contact with the first abutting piece **96** of the lever **92** so that the first abutting piece **96** is moved to slide to the outside in the cross direction **121**, i.e., on the left side in FIGS. **7**A to **7**C, against the biasing force of the coil spring **94**. In response to the sliding movement of the lever **92** as such, the object **91** is also moved to slide to the outside in the cross direction **121** together with the lever **92**. In this state with the space **115** remained intact, in the carriage **41** located on the end position, the position to be detected by the sheet detection sensor **32** mounted to such a carriage **41** corresponds to the space **115**. That is, the sheet detection sensor **32** detects any light reflected by the upper surface of the platen **43** via the space **115**.

As shown in FIG. **7**C, when the protrusion **80** of the transmission gear **77** comes in contact with the detecting portion **114** of the object **91**, against the biasing force of the coil spring **95**, the detecting portion **114** is moved to slide toward the center in the cross direction **121**, i.e., on the right side in FIGS. **7**A to **7**C, along the inclined surface **81** of the protrusion **80**. When the surface **83** of the protrusion **80** comes in contact with the detecting portion **114**, the space **115** is accordingly closed. In such a state with the closed space **115**, in the carriage **41** on the end position, the position to be detected by the sheet detection sensor **32** mounted to such a carriage **41** corresponds to the detecting portion **114**. That is, the sheet detection sensor **32** detects the light reflected by the detecting portion **114**.

Control Section **100**

The control section **100** of FIG. **8** is in charge of controlling not only the printer section **11** but also entirely over the multifunctional device **10**. The control section **100** is configured as a microcomputer, mainly including a CPU (Central Processing Unit) **101**, a ROM (Read-Only Memory) **102**, a RAM (Random-Access Memory) **103**, EEPROM (Electrically Erasable Programmable ROM) **104**, and an ASIC (Application Specific Integrated Circuit) **109**. Such a control section **100** serves as printing section detection means, origin determining section, correction section, and control section. Note that, in FIG. **8**, transmission paths for a driving force coming from motors **85**, **86**, and **87** are each indicated by broken lines.

The ROM **102** stores therein a program for the CPU **101** to control the motors **85**, **86**, and **87**, and the multifunctional device **10**, for example. The RAM **103** is used as a storage area or a working area by the CPU **101**, i.e., a storage area for a temporary storage of various types of data for use by the CPU **101** to run the above-described program, and a working area for data processing or others. Such a RAM **103** stores therein a current rotation phase of the transfer roller **60** (hereinafter, referred to as "current phase θ"). This current phase θ is updated as appropriate in response to every rotation of the transfer roller **60**. The EEPROM **104** stores therein the setting details, flags, and others, which are those needed to be stored even after the power is turned off. This EEPROM **104** also stores therein a correction value function A(θ), which will be described later. This correction value function A(θ) defines the correlation between the current phase θ of the transfer roller **60** and a correction value related to the printing paper **50**, i.e., the transfer amount thereof per rotation amount of the transfer roller **60**. The correction value function A(θ) is with the correlation returning a correction value through substitution of a variable θ. Such a correction function may be stored in the form of a table, or may be stored by following a rule such as polynomial or others. When the correction function is stored by following polynomial, the polynomial may be stored in the ROM **102**, and only coefficients of the respective factors of the polynomial may be stored in the EEPROM **104**.

The ASIC **109** is connected with the sheet detection sensor **32**, driving circuits **72**, **73**, and **74**, a linear encoder **88**, and a rotary encoder **89**. Herein, the control section **100** is connected with the scanner section **12**, the operation panel **14**, and others, but such a connection is not limited to the embodiment described here.

The driving circuit **72** is for driving the LF motor **85**. The LF motor **85** is coupled with the shaft **76** of the transfer roller **60**, and the shaft of the sheet ejection roller **62** via the transmission gears **77** and **78**, and others. The driving circuit **72** drives the LF motor **85** in response to an output signal coming from the ASIC **109**. The driving force of the LF motor **85** is transmitted to the shaft **76** or others, and in response thereto, the transfer roller **60** and the sheet ejection roller **62** start rotating synchronously. After reaching the transfer path **19**, the printing paper **50** is moved therealong by the rotation force of the transfer roller **60** or that of the sheet ejection roller **62**, and then is ejected onto the upper surface **23** of the sheet feeding cassette **22**. The transfer roller **60** is coupled with the sensing member **90** via the transmission gear **77**. When the transfer roller **60** is rotated, in conjunction therewith, the object **91** of the sensing member **90** is moved to slide in the cross direction **121**.

The driving circuit **73** is operated to drive the CR motor **86** in response to an output signal from the ASIC **109**. The driving force of the CR motor **86** is transmitted to the carriage **41** via the belt drive mechanism **46** so that the carriage **41** is moved in the cross direction **121**.

The driving circuit **74** is for driving the ASF motor **87**. The ASF motor **87** is coupled with the sheet feeding roller **25** or **35** via the drive transmission mechanism that is not shown. The driving circuit **74** is operated to rotate the ASF motor **87** in response to an output signal coming from the ASIC **109**. The drive transmission mechanism then transmits the driving force of the ASF motor **87** selectively to the sheet feeding roller **25** or **35**. The printing paper **50** located at the top in the sheet feeding cassette **21** or **22** is directed to the transfer paths **18** and **19** by the rotation force of the sheet feeding roller **25** or **35**.

The sheet detection sensor **32** outputs an analog electric signal (voltage signal or current signal) corresponding to the amount of light received by the light-receiving elements. When the signal coming from the sheet detection sensor **32** as such is of an electric level (voltage or current value) equal to or higher than a predetermined threshold value, the control section **100** determines that the signal is HI in level, and is LOW in level when such a level is smaller than the predetermined threshold value. In this embodiment, the signal coming from the sheet detection sensor **32** is determined as HI in level when the receiving light is the one reflected by the printing paper **50** in the color of white or by the detecting portion **114** of the sensor **90**, and is determined as LOW in level when the receiving light is the one reflected by the upper surface of the platen **43** in the color of black.

The linear encoder **88** is for detecting the pattern of the encoder strip **51** using the optical sensor **52** mounted to the carriage **41**, and for outputting a pulse signal. Based on the pulse signal to be output as such, the control section **100** determines the speed and position of the carriage **41**, thereby controlling the driving of the CR motor **86**.

The rotary encoder **89** is operated to detect the marks on the encoder disk **71** using the optical sensor **55**, and output a pulse signal. Based on the pulse signal to be output as such, the control section **100** determines the rotation amount of the transfer roller **60**, thereby controlling the driving of the LF motor **85**.

Herein, for achieving the transfer of the printing paper **50** in the printer section **11** with high accuracy, preferably, the rotation amount of the transfer roller **60** to be detected by the rotary encoder **89** has the linearity with the actual transfer amount of the printing paper **50** by the transfer roller **60**. When there is no slip between the transfer roller **60** and the printing paper **50**, the transfer amount of the printing paper **50** shows a match with the movement amount of the transfer roller **60** on the surface. However, because the movement amount of a rotation body on the surface is the product of the rotation radius and the rotation angle, if the rotation radius of the transfer roller **60** varies, the transfer amount of the printing paper **50** resultantly varies. This is applicable also to the sheet ejection roller **62**.

FIG. **9**A shows the transfer roller **60** whose shaft **76** is attached with the eccentric encoder disk **71**. With such eccentricity of the encoder disk **71** or any other factors, the transfer amount of the printing paper **50** by the transfer roller **60** to be detected by the rotary encoder **89** per rotation amount shows a variation on a cycle basis (shown in FIG. **9**B). The other factors include the warping of the transfer roller **60**, the uneven thickness of coating, the eccentricity of the transmission gear **77** engaged to the shaft **76** of the transfer roller **60**, and others. The cycle herein is a rotation of the transfer roller **60**. In the example of FIGS. **9**A and **9**B, when the encoder disk **71** is detected as being on a position B, the transfer amount of the printing paper **50** is high per pulse signal coming from the rotary encoder **89**. Conversely, when the encoder disk **71** is detected as being on a position D, the transfer amount of the printing paper **50** is low per pulse signal coming from the rotary encoder **89**. As such, the transfer amount of the printing paper **50** by the transfer roller **60** varies on a cycle basis.

As such, for reducing such a cyclic variation of the transfer amount by the transfer roller **60**, the control section **100** controls the driving of the LF motor **85** to correctly make uniform the transfer amount of the printing paper **50** by the transfer roller **60**. The EEPROM **104** stores therein the correction value function A(θ) for use with such a correction process for the rotation amount by the transfer roller **60**. Described below is the process of acquiring the correction value function A(θ). Note here that this correction value function A(θ) is acquired before the shipment of the multifunctional device **10**, and is written in advance into the EEPROM **104**. Alternatively, the correction value function A(θ) may be written into the EEPROM **104** by a user executing a predetermined operation with instructions found in a manual or displayed on the operation panel **14** at the time of starting to use the multifunctional device **10**.

Acquisition of Correction Value Function A(θ)

In this embodiment, the transfer roller **60** is so configured that the printing paper **50** is moved forward by 1.2 inches with a rotation of the transfer roller **60**. The printhead **42** has the resolution of 150 dpi (dot per inch) for the nozzles in the transfer direction **124**. This means that the nozzles are arranged at uniform intervals of 1/150 inches. With a rotation of the encoder disk **71**, 8640 pulse signals are to be output from the rotary encoder **89**.

The control section **100** controls the driving of the ASF motor **87**, thereby directing the printing paper **50** from the sheet feeding cassette **21** or **22** to the transfer path **19**. The control section **100** also controls the operation of the printing section **40**, thereby making the printing section **40** to record, on the tip end side of the printing paper **50**, a line extending long in the cross direction **121** (shown in FIG. **10**A). To be more specific, the control section **100** moves the carriage **41** from one end side to the other end side in the cross direction **121** by a first distance, and at the same time, bursts the ink from the nozzle located on the most upstream in the transfer direction **124** of the printhead **42**, i.e., first nozzle. As such, when a long line is drawn on the printing paper **50** at its tip end side, the control section **100** controls the driving of the LF motor **85**, thereby moving forward the printing paper **50** by the amount of a pulse signal, i.e., 0.57 inches. More specifically, the control section **100** keeps driving the LF motor **85** until 4104 (=8640/1.2×0.57) pulse signals are provided by the rotary encoder **89** to make the transfer roller **60** to move the printing paper **50**. The LF motor **85** is stopped after the number of the pulse signals provided by the rotary encoder **89** reaches 4104.

Next, the control section **100** makes the printing section **40** to record, on the printing paper **50**, a short line extending in the cross direction **121** (shown in FIG. **10**B). More specifically, the control section **100** moves the carriage **41** from one end side to the other end side in the cross direction **121** by a second distance shorter than the first distance, and at the same time, bursts the ink from the nozzle positioned 91st from the most upstream side in the transfer direction **124** of the printhead **42**, i.e., 91st nozzle. Because the printhead **42** has the resolution of 150 dpi for the nozzles in the transfer direction **124**, the distance between the first and 91st nozzles in the transfer direction **124** is 0.6 (=(91−1)/150) inches. It means, ideally, the 91st nozzle is away from the long line by 0.03 (=0.6−0.57) inches in the transfer direction **124**.

The control section **100** alternately repeats the operation of making the printing section **40** to draw a short line, and the operation of making the LF motor **85** to move forward the printing paper **50** by the amount of a pulse signal (8640/1.2×0.01), i.e., 0.01 inches. This accordingly records seven short lines on the printing paper **50** (shown in FIG. **10**C). Note here that the printhead **42** performs the printing operation while changing the position of the carriage **41** in the cross direction **121** to vary the positions of these seven short lines in the cross direction **121**.

The control section **100** then repeats the process of printing another long line at the position ahead from the lastly-recorded long line by 0.1 inches, and printing seven short lines with respect to the resulting long line (shown in FIG. **10**D). By repeating such a process of printing a long line and seven short lines as a pattern, twelve patterns in total are recorded on the printing paper **50** (FIG. **11**(A)). Note that, for forming a pattern by transferring the printing paper **50** always in the same direction, the printing order of the long and short lines may be reversed from the one described above. For forming a pattern by transferring the printing paper **50** always in the same direction, a second long line to be recorded at the position ahead from a first long line by 0.1 inch is recorded earlier than a first short line recorded for the first long line at the position ahead therefrom by 0.57 inch, for example. Such an order of pattern printing does not affect the result of an operation that will be described later for finding the correlation between the transfer amount of the printing paper **50** and the phase of the transfer roller **60**. The recorded lines may serve their purposes as long as each show a predetermined relative positional relationship.

Thereafter, in the respective patterns, a determination is made which of the short lines coincides best with the long line, or if the long line falls between the short lines, which two of the short lines coincides best with the long line. More in detail, the printing paper **50** is placed on the contact glass of the scanner section **12**, and the scanner section **12** is operated to perform image reading of the printing paper **50**. The control section **100** then determines which of the short lines coincides best with the long line, or if the long line falls between the short lines, which two of the short lines coincides best with the long line. Such a determination process is executed to each of the patterns. Herein, assuming that the short lines drawn for each long line are numbered 1 to 7 in order from the left, if with the printing paper **50** of FIG. **11**A, starting from the long line at the top in FIG. **11**A, the numbers are to be 3, 2. 5, 2, 3, 4, 4, 5, 6, 6.5, 6, 4, and 3.5. Herein, when the long line falls between the two short lines, the number to be taken is an average value between the numbers of the two short lines.

The first and 91st nozzles are away from each other by 0.6 inches in the transfer direction **124**. Accordingly, when the number is 4, with respect to the target transfer amount of 0.6 (=0.57+0.01×(4−1)) inches, the actual movement of the printing paper **50** is 0.6 inches. When the number is 3, with respect to the target transfer amount of 0.59 (=0.57+0.01×(3−1)) inches, the actual movement of the printing paper **50** is 0.6 inches. This indicates that the printing paper **50** is moved by the circumferential surface of the transfer roller **60** on the side of the position B of FIG. **9**A. When the number is 5, with respect to the target transfer amount of 0.61 (=0.57+0.01×(5−1)) inches, the actual movement of the printing paper **50** is 0.6 inches. This indicates that the printing paper **50** is moved by the circumferential surface of the transfer roller **60** on the side of the position D of FIG. **9**A.

The graph of FIG. **9**B can be derived by allocating the number of pulses on the lateral axis by a cycle of 1/12 (720 pulses), and by representing, in ratio, the transfer amount per the number of pulses on the vertical axis with respect to the target transfer amount (shown in FIG. **11**B). That is, the resulting graph helps to keep track of how the transfer amount of the printing paper **50** is changed with respect to the target transfer amount during a rotation of the transfer roller **60**.

As long as the rotary encoder **89** keeps detecting the rotation of the transfer roller **60**, the rotation amount of the current encoder disk **71** can be kept track of The rotation amount here is the one with respect to the rotation phase of the encoder disk **71** when a long line of the pattern of FIG. **11**A is recorded for the first time on the printing paper **50**. As such, when a command comes for transferring the printing paper **50**, by referring to the graph described above, an average difference may be calculated for the transfer amount of the transfer roller **60** from the current position to the position at the time of completion of the transfer, and the target transfer amount may be corrected in consideration of the influence thereof. If this is the case, any possible cyclic variation can be suppressed for the transfer amount of the printing paper **50**.

Herein, the rotation phase of the encoder disk **71** when the long line is recorded for the first time is so controlled as to coincide with the position of an origin of the transfer roller **60** that will be described later, or to be at the position with a predetermined phase difference from the position of the origin. In this embodiment, the correction value function $A(\theta)$ is generated for correcting the target transfer amount of the printing paper **50** based on the graph of FIG. **11**B, and the resulting function is stored in the EEPROM **104**. Accordingly, even if the multifunctional device **10** is turned off and then on again, by detecting a physical starting point of the transfer roller **60**, the rotation amount of the transfer roller **60** can be appropriately corrected.

Determination of Origin

By referring to the flowchart of FIG. **12**, described next is the process procedure to be executed in the printer section **11** in response to when the multifunctional device **10** is turned on. Note that processes to be described below by referring to the flowchart are executed in response to a command issued by the control section **100** based on the program stored in the ROM **102**.

The control section **100** determines whether or not the multifunctional device **10** is turned on based on whether a predetermined input key is operated or not on the operation panel **14** (S**1**). When determining that the multifunctional device **10** is not yet turned on (S**1**: NO), the control section **100** is put on standby. When determining that the multifunctional device **10** is turned on (S**1**: YES), the control section **100** drives the CR motor **86** through control over the driving circuit **73** (S**2**). Note that, when the multifunctional device **10** is turned off, the control section **100** moves the carriage **41** to its home position. This home position is located within a movement range of the carriage **41** to move back and forth, and is at the end opposite to the transmission gear **77**, i.e., on the right side in FIG. **3**. Herein, within the movement range of the carriage **41** to move back and forth, another end where the transmission gear **77** is positioned is referred to as end position, i.e., on the left side in FIG. **3**. This end position is an example of a sensing position.

In response to the driving of the CR motor **86**, the carriage **41** at the home position starts moving to the end position thereof. The control section **100** then determines whether or not the carriage **41** reaches the end position based on the detection result of the linear encoder **88** (S**3**). Until the carriage **41** reaches the end position, the CR motor **86** is continuously driven. When the carriage **41** reaches the end position (S**3**: YES), the control section **100** stops the driving of the CR motor **86** (S**4**).

When the carriage **41** is positioned on the end position, the control section **100** performs flushing (S**5**). Although this flushing is not necessarily performed, if the carriage **41** remains at the end position for a long time during the process procedure to be described below, the flushing is preferably performed without fail to prevent drying of the printhead **42** and clogging of the nozzles during that time.

When the carriage **41** is positioned on the end position, as shown in FIG. **7**B, the abutting section **53** of the carriage **41** comes in contact with the first abutting piece **96** of the lever **92** so that the lever **92** is moved to slide. The sheet detection sensor **32** mounted to the carriage **41** thus becomes ready for detection of any light reflected by the upper surface of the platen **43** via the space **115**. At the end position as such, the control section **100** turns on the sheet detection sensor **32** (S**6**). Herein, the sheet detection sensor **32** may be already turned on before the process of S**6**.

The concern here is that, when the carriage **41** is positioned on the end position as described above (S**3**), the surface **83** of the protrusion **80** formed to the transmission gear **77** may possibly come in contact with the object **91** of the sensing member **90**. If this is the case, as shown in FIG. **7**C, the space **115** will not be formed in the sensing member **90**, and thus the sheet detection sensor **32** may detect the detecting portion **114**. In this case, a signal coming from the sheet detection sensor **32** is determined as HI in level (S**7**: YES).

When determining that the signal coming from the sheet detection sensor **32** as HI in level, the control section **100** drives the LF motor **85** to rotate the transfer roller **60** by 1/N (where N is a natural number other than 1) of a rotation (S**8**). The control section **100** then stops the driving of the LF motor **85** (S**9**), and ends the flushing (S**10**). This accordingly stops the driving of the transmission gear **77** at a rotation position where the protrusion **80** does not come in contact with the object **91** of the sensing member **90**. The rotation amount of the transfer roller **60** herein, i.e., 1/N of a rotation thereof, may be arbitrarily set as long as the number is not an integral multiple of the rotation cycle.

The control section **100** then returns the carriage **41** to the home position at one end (S**11**), and then positions the carriage **41** again on the end position (S**3**). This accordingly positions the carriage **41** on the end position with no contact of the protrusion **80** of the transmission gear **77** with the object **91** of the sensing member **90**.

When determining that the signal coming from the sheet detection sensor **32** as LOW in level (S**7**: NO), the control section **100** drives the LF motor **85** (S**12**). In response to the driving of the LF motor **85**, the transmission gear **77** starts rotating so that the transfer roller **60** and the sheet ejection roller **62** also start rotating. When the transmission gear **77** has a predetermined rotation phase, the protrusion **80** comes in contact with the object **91** of the sensing member **90**. More in detail, either the inclined surface **81** or **82** of the protrusion **80** comes in contact with the detecting portion **114** of the object **91**, and thus the transmission gear **77** is rotated to a further degree so that the detecting portion **114** of the object **91** is moved from the inclined surface **81** or **82** to the surface **83**. As a result, the detecting portion **114** is moved to slide by the protrusion **80** to be pushed toward the home position, and thus the space **115** is closed (shown in FIG. **7**C). Such a contact between the protrusion **80** and the object **91** of the sensing member **90** is made once every rotation of the transmission gear **77**.

While the LF motor **85** is driven, the control section **100** monitors any output change of the sheet detection sensor **32**. As described above, the transmission gear **77** is formed with one protrusion **80**, and when the transmission gear **77** rotates once, the protrusion **80** comes in contact once with the object **91** of the sensing member **90**. When the object **91** of the sensing member **90** is moved toward the home position, the space **115** is closed, and the sheet detection sensor **32** that has been receiving the reflected light from the upper surface of the platen **43** via the space **115** starts receiving the reflected light from the detecting portion **114** of the object **91**. Accordingly, during a rotation of the transmission gear **77**, the determination about the output from the sheet detection sensor **32** is changed from LOW to HI, and then to LOW again.

When the control section **100** detects a change from LOW to HI observed in the output from the sheet detection sensor **32**, i.e., so-called "rising" of signal (S**13**; YES), the current phase θ of the transfer roller **60** is defined at the respective points in time (S**16**). Such a definition is made with the current phase θ of the rotary encoder **89** being 0 at the time of detection as such, i.e., origin, and the phase of the rotary encoder **89** thereafter from this position is accumulated. Information about the origin of this transfer roller **60** is stored in the RAM **103**. Note that, in this embodiment, the setting is so made that the rising position of the signal is at the origin. This is surely not restrictive, and alternatively, any characteristic point may be used as an origin as long as the characteristic point is the one appearing only once during a rotation of the transmission gear **77**, e.g., the falling position of the signal, or an intermediate position between the falling and rising positions.

Thereafter, the control section **100** determines whether or not the current phase θ of the transfer roller **60** reaches the position of the origin (S**17**). Such a determination is made based on the detection result of the rotary encoder **89**, and information about the position of the origin stored in the RAM **103**. When determining that the current phase θ of the transfer roller **60** is not yet at the position of the origin (S**17**: NO), the control section **100** keeps driving the LF motor **85** until the current phase θ of the transfer roller **60** reaches the position of the origin. When determining that the current phase θ of the transfer roller **60** is now at the position of the origin (S**17**: YES), the control section **100** stops the driving of the LF motor **85** (S**18**), and ends the flushing (S**19**).

When the transfer roller **60** is rotated once without determining that the output from the sheet detection sensor **32** is HI in level (S**13**: NO), more specifically, when determining that the number of the pulse signals provided by the rotary encoder **89** is now **8640** (S**14**: YES), the control section **100** determines that the object **91** of the sensing member **90** is not detected. The control section **100** thus makes an error display on the display of the operation panel **14** (S**15**), stops the driving of the LF motor **85** (S**18**), and ends the flushing (S**19**).

Transfer Operation of Printing Paper **50**

By referring to the flowchart of FIG. **13**, described now is the process procedure to be executed in the printer section **11** when a printing start command is provided to the multifunctional device **10**.

The control section **100** determines whether a printing start command is provided or not (S**21**). More specifically, the control section **100** determines whether or not receiving, from an external information device, a printing start command and printing data, or whether or not any operation input is made on the operation panel **14** to start printing. When determining that such a printing start command is not yet provided (S**21**: NO), the control section **100** is put on standby.

When determining that such a printing start command is provided (S**21**: YES), the control section **100** reads the correction value function A(θ) from the EEPROM **104** (S**22**). The control section **100** then reads the current phase θ of the transfer roller **60** from the RAM **103** (S**23**). This current phase θ represents the rotation angle of the transfer roller **60** from the position of the origin. Next, the control section **100** acquires a target rotation amount Xm, which is the number of the pulse signals provided by the rotary encoder **89** until the printing paper **50** is moved to the target position (S**24**). The control section **100** then substitutes the current phase θ into the correction value function A(θ) read in step S**22**, thereby computing a correction value C representing the number of the pulse signals (S**25**).

The control section **100** corrects the target rotation amount Xm by adding the correction value C to the target rotation amount Xm acquired by the process in step S**24** (S**26**). The control section **100** then updates the current phase θ based on the target rotation amount Xm as a result of the correction as above (S**27**). Herein, because the current phase θ represents the rotation angle of the transfer roller **60** from the position of the origin, when the value becomes larger than 2π, 2π is subtracted from the value. When the value becomes negative, the value is added with 2π. In such a manner, the value of the current phase θ is so adjusted as to always satisfy the relationship of $0 \leqq \theta \leqq 2\pi$. Note that described above is the case that the phase of the transfer roller **60** is the radian, but alternatively, any other unit proportional to the radian may be surely an option.

Next, the control section **100** drives the LF motor **85** (S**28**). The control section **100** then determines whether or not the rotation amount of the transfer roller **60** detected by the rotary encoder **89** reaches the target rotation amount Xm as a result of the correction by the process in step S**26** (S**29**). More specifically, the control section **100** determines whether or not the number of the pulse signals provided by the rotary encoder **89** reaches the target rotation amount Xm. When the control section **100** determines that the rotation amount of the transfer roller **60** does not yet reach the target rotation amount Xm (S**29**: NO), the procedure is returned to step S**28**. That is, the LF motor **85** is continuously driven until the rotation amount of the transfer roller **60** reaches the target rotation amount Xm.

During the rotation of the transfer roller **60**, a cyclic difference is generated to the actual rotation amount of the transfer roller **60** from the rotation amount thereof detected by the rotary encoder **89**. The cyclic difference is with a cycle of the rotation of the transfer roller **60**. In this embodiment, based on the position of the origin of the transfer roller **60** acquired after the multifunctional device **10** is turned on, the current phase θ of the transfer roller **60** is determined, and the target rotation amount Xm is corrected using the correction value C corresponding to the current phase θ. As such, the driving of the LF motor **85** is so controlled that the rotation amount of the transfer roller **60** matches considering the target rotation amount Xm as a result of the correction. The cyclic difference observed in the rotation amount of the transfer roller **60** is thus cancelled out so that the printing paper **50** can be transferred with good accuracy to the target position.

When determining that the rotation amount of the transfer roller **60** reaches the target rotation amount Xm (S**29**: YES), the control section **100** stops the driving of the LF motor **85** (S**30**). The control section **100** then makes the printing section **40** to perform image printing (S**31**). To be more specific, the control section **100** moves the carriage **41** from one end side to the other end side in the cross direction **121**, and at the same time, bursts the ink from the printhead **42**.

The control section **100** then determines whether or not the transfer operation of the printing paper **50** is completed (S**32**). When the control section **100** determines that the transfer operation of the printing paper **50** is not yet completed (S**32**: NO), the procedure is returned to step S**24**. That is, the procedure repeats the processes from steps S**24** to S**29**. As such, the process of rotating the transfer roller **60** by the target rotation amount Xm is repeated alternately with the process of image printing on the printing paper **50** so that the printing paper **50** is sequentially recorded with images. When the control section **100** determines that the transfer operation of the printing paper **50** is completed (S**32**: YES), this is the end of the process procedure.

Advantages and Effects of Embodiment

As described in the foregoing, the position of the origin of the transfer roller **60** is determined by the sheet detection sensor **32** detecting the object **91** of the sensing member **90**. The sheet detection sensor **32** here is the one mounted to the carriage **41** at the end position, and the sensing member **90** here is the one to be moved to slide in conjunction with the rotation of the transfer roller **60**. Accordingly, by effectively utilizing the components provided in the printer section **11** for any other purposes, e.g., the sheet detection sensor **32**, and the transmission gear **77**, the position of the origin of the transfer roller **60** can be determined without causing any possible increase of device size and cost.

Also in the embodiment, the correction value C corresponding to the current phase θ of the transfer roller **60** is acquired by applying the current phase θ of the transfer roller **60** to the correction value function A(θ) stored in the EEPROM **104**. The current phase θ of the transfer roller **60** here is the one found with reference to the position of the origin determined by the control section **100**. By using the correction value C acquired as such, the target rotation amount Xm is corrected. With the rotation of the transfer roller **60** by the target rotation amount Xm after the correction as such, the cyclic variation of the printing paper **50** in terms of transfer amount can be suppressed. As a result, the printing paper **50** will be transferred intermittently with almost a constant line-feed width so that the printing paper **50** can be recorded thereon with clear images with no disturbance.

Also in the embodiment, the printhead **42** is subjected to flushing at the end position during the detection of the position of the origin of the transfer roller **60**. Therefore, during the detection of the position of the origin as such, the area in the vicinity of the nozzles of the printhead **42** may not dry as previously has been, thereby being able to prevent any possible clogging of the ink.

Also in the embodiment, when the carriage **41** is moved to the end position, if the protrusion **80** of the transmission gear **77** is contacting with the object **91** of the sensing member **90**, i.e., if the signal provided by the sheet detection sensor **32** is determined as HI in level, the carriage **41** is moved to the home position once by rotating the transfer roller **60** by the amount other than the integral of a rotation cycle, and then moves the carriage **41** back to the end position again. As such, the protrusion **80** of the transmission gear **77** is put in the state of not contacting with the object **91** of the sensing member **90**. This accordingly enables to determine the origin of the transfer roller **60** without fail.

In the embodiment above, described is the configuration in which the object **91** of the sensing member **90** is moved to slide by the protrusion **80** formed to the transmission gear **77**. Alternatively, the drive transmission mechanism may be well-known type such as gear, belt, cam, or others.

Also in the embodiment above, described is the configuration in which the rotary encoder **89** is used to detect the rotation amount of the transfer roller **60**. This is surely not restrictive, and as an alternative to the rotary encoder **89**, a magnetic sensor or others may be used for detecting the rotation amount of the transfer roller **60**. Moreover, the physical amount to be detected by the sheet detection sensor **32** may be the electric or magnetic field of any opposing area. If this is the case, the object **91** of the sensing member **90** may be charged or magnetized differently from the other remaining portions in terms of amount.

Also in the embodiment, described is the configuration in which an electric signal coming from the sheet detection sensor **32** is determined as either the binary level of HI or LOW based on a predetermined threshold value, and the rising or falling position of the electric signal, i.e., a characteristic point, is used as a basis to determine the position of an origin. Alternatively, the electric signal coming from the sheet detection sensor **32** may not be in binary but may be converted into a digital signal of a plurality of bits such as 8 and 16, or may be handled as an analog value as it is. Moreover, the characteristic point is not restrictive to the rising or falling position of the signal but may be a maximum or minimum value for use as a basis to determine the position of an origin, for example.

Also in the embodiment, described is the configuration in which the LF motor **85** is a DC motor, but alternatively, the LF motor **85** may be a stepping motor. If this is the case, the rotary encoder **89** is not required for use, and the motor pulse count in the control section **100** corresponds to the first sensor.

Also in the embodiment, described is the configuration in which the target rotation amount is corrected only for the transfer roller **60**. Alternatively, when the printing paper **50** is transferred only by the sheet ejection roller **62** not going through the transfer roller **60**, similarly to the correction of the target rotation amount of the transfer roller **60**, the target rotation amount of the sheet ejection roller **62** may be corrected relative to the position of the origin of the transfer roller **60**.

First Modified Example

By referring to FIGS. **14**A to **14**C, described below is a first modified example of the embodiment above. Unlike the embodiment above, in the first modified example, as an alternative to the sensing member **90** in the above embodiment, a sensing member **130** (an example of the reference member) of another configuration is provided. The remaining configuration is the same as that of the embodiment above. Herein, a detailed description is given only about the sensing member **130** but not about the remaining configuration.

Sensing Member **130**

Although not shown in the drawings, the sensing member **130** is disposed in the vicinity of an end portion where the transmission gear **77** is positioned on the platen **43**. This sensing member **130** is operated by the protrusion **80** of the transmission gear **77**.

As shown in FIGS. **14**A to **14**C, the sensing member **130** is configured to mainly include an object **131**, a lever **132**, a supporting member **133**, and coil springs **134** and **135**. The supporting member **133** is fixed to the upper surface of the platen **43**. This supporting member **133** is incorporated with the object **131** and the lever **132** to be able to slide in the cross direction **121**. The supporting member **133** is provided with walls **128** and **129**, which are disposed with a distance therebetween in the cross direction **121**. The object **131** and the lever **132** are allowed to slide in the cross direction **121** as such between the walls **128** and **129**.

The lever **132** is configured by first and second abutting pieces **136** and **137**, which are coupled together by a shaft **138**. The first and second abutting pieces **136** and **137** are disposed with a distance therebetween in the cross direction **121**, and the shaft **138** extends along the cross direction **121**. This shaft **138** is coupled with, at its both ends, the first and second abutting pieces **136** and **137**, respectively. The first and second abutting pieces **136** and **137** are so disposed that the second abutting piece **137** is located on the side of the transmission gear **77**. In a range where the lever **132** is moved to slide in the cross direction **121**, the first abutting piece **136** is allowed to come in contact with the wall **128** of the supporting member **133**. The position where the first abutting piece **136** comes in contact with the wall **128** of the supporting member **133** as such is the end of the range where the first abutting piece **136** is allowed to slide toward the center in the cross direction **121**, i.e., on the right side in FIGS. **14**A to **14**C. Between the second abutting piece **137** and the wall **129** of the supporting member **133**, the coil spring **134** is provided. The second abutting piece **137** and the wall **129** each serve as a spring seat of the coil spring **134**. The coil spring **134** is disposed between the second abutting piece **137** and the wall **129** of the supporting member **133**, and is compressed. By such a coil spring **134**, the lever **132** is biased toward the center in the cross direction **121**.

The object **131** is incorporated to the shaft **138** of the lever **132**, thereby being allowed to move circular in a rotation direction **125**. More in detail, the object **131** is extended all the way to the supporting member **133** and longer from the shaft **139**, and is coupled to the shaft **138** to be able to freely slide. The shaft **139** here is the one disposed on the downstream side than the supporting member **133** in the transfer direction **124**. The extension end of the object **131** is increased in width in the cross direction **121**, and on the side opposing the transmission gear **77**, an abutting section **140** is formed. This abutting section **140** is allowed to come in contact with the protrusion **80** of the transmission gear **77**. Although the coupling configuration between the object **131** and the shaft **138** of the lever **132** is not shown in the drawings, the object **131** is formed with a coupling section formed with a through hole that projects downward to go through in the cross direction **121**. Through this through hole formed to the coupling section, the shaft **138** is inserted so that the object **131** is incorporated to the shaft **138** to be able to freely slide.

The object **131** is so configured as to have a reflectivity different from that of the upper surface of the platen **43**. This is for the object **131** to output an electric signal of varying level between when the sheet detection sensor **32** is opposing the object **131**, and when it is opposing the upper surface of the platen **43**. Such a difference of reflectivity is implemented by a different surface roughness between the object **131** and the upper surface of the platen **43**, a different face angle therebetween, a different surface material therebetween, or others. In this embodiment, such a difference of reflectivity is achieved by different coloring between the object **131** and the upper surface of the platen **43**. More specifically, the upper surface of the platen **43** is colored black, and the object **131** is colored white.

The coil spring **135** is disposed between the first abutting piece **136** of the lever **132** and the object **131**. This coil spring **135** is externally wound around the shaft **138**. The first abutting piece **136** and the object **131** each serve as a spring seat of the coil spring **135**. The coil spring **135** is disposed between the first abutting piece **136** and the object **131**, and is compressed. By such a coil spring **135**, the object **131** is biased to move circular toward the outside in the cross direction **121**, i.e., on the side of the transmission gear **77**.

As shown in FIG. **14**A, when the sensing member **130** is free from any external force, the lever **132** is moved to slide toward the center in the cross direction **121** by being biased by the coil spring **134** so that the first abutting piece **136** comes in contact with the wall **128** of the supporting member **133**. Moreover, the object **131** is contacting with the second abutting piece **137** by being biased by the coil sprint **135**.

As shown in FIG. **14**B, when the carriage **41** is moved to the end position, i.e., the position shown in FIG. **3**, the abutting section **53** of the carriage **41** comes in contact with the first abutting piece **136** of the lever **132** so that the first abutting piece **136** is moved to slide to the outside in the cross direction **121**, i.e., on the left side in FIGS. **14**A to **14**C, against the biasing force of the coil spring **134**. In response to the sliding movement of the lever **132** as such, the object **131** is also moved circular toward the outside in the cross direction **121** together with the lever **132**. In this state, the object **131** is contacting with the second abutting piece **137** by being biased by the coil spring **135**. In the carriage **41** positioned on the end position, the position to be detected by the sheet detection sensor **32** mounted to such a carriage **41** is a position **141** located on the side closer to the center in the cross direction **121** than the object **131** in the above-described state. That is, the sheet detection sensor **32** detects any light reflected by the upper surface of the platen **43**.

As shown in FIG. **14**C, when the protrusion **80** of the transmission gear **77** comes in contact with the abutting section **140** of the object **131**, against the biasing force of the coil spring **135**, the object **131** is moved circular toward the center in the cross direction **121**, i.e., on the right side in FIGS. **14**A to **14**C, along the inclined surface **81** of the protrusion **80**. When the surface **83** of the protrusion **80** comes in contact with the object **131**, the object **131** accordingly covers the upper side of the position **141**. In such a state, the sheet detection sensor **32** mounted to the carriage **41** positioned on the end position detects any light reflected by the object **131**.

Second Modified Example

Described next is a second modified example of the embodiment above. Unlike the embodiment above, in the second modified example, as an alternative to the sensing member **90**, a sensing mechanism **150** of another configuration is used, and as an alternative to the protrusion **80** of the transmission gear **77**, a cam **149** is provided to the shaft **76** of the transfer roller **60**. The remaining configuration is the same as that of the embodiment above, and thus a detailed description is given only about the sensing mechanism **150** and the cam **149** but not about the remaining configuration. The sensing mechanism **150** corresponds to the sensing member as an example of the reference member, and the cam **149** corresponds to the position of the drive transmission mechanism.

Sensing Mechanism **150**

As shown in FIG. **15**, the sensing mechanism **150** is disposed on the lower side of the platen **43**. There is no specific limitation where the sensing mechanism **150** is to be disposed relative to the platen **43** in the cross direction **121**. This sensing mechanism **150** is the one operated by the carriage **41** and the cam **149**. Note that, in FIG. **15**, the platen **43** and a window **33** are each indicated by broken lines. The window **33** is a through hole formed to one of the two ends of the platen **43** in the cross direction **121**, i.e., the end on the side of the transmission gear **77**, to correspond to the sheet detection sensor **32** in the transfer direction **124**.

As shown in FIG. **15**, the sensing mechanism **150** is configured to mainly include an object **151**, a release lever **152**, and coil springs **153** and **154**. The object **151** is supported on the rear side of the platen **43** to be able to slide in the cross direction **121**. The object **151** is shaped like a flat plate extending long in the cross direction **121**, and an end portion on the center side in the cross direction **121**, i.e., on the right side in FIG. **15**, serves as a detection section **155**. This detection section **155** is so configured as to have a reflectivity different from that of other remaining components. This is for the detection section **155** to output an electric signal of varying level between when the sheet detection sensor **32** is opposing the detection section **155**, and when it is opposing the other remaining components. In this modified example, the detection section **155** is colored white, and the other remaining components are colored black.

Almost at the center of the object **151** in the cross direction **121**, an engaging portion **156** is formed to project toward the shaft **76** of the transfer roller **60**. The engaging portion **156** is a surface **157** on the center side in the cross direction **121**, i.e., on the right side in FIG. **15**, placed along the transfer and height directions **124** and **122**. On the other hand, in the engaging portion **156**, a surface **158** on the side of the transmission gear **77** in the cross direction **121**, i.e., on the left side in FIG. **15**, is so inclined to the side of the transmission gear **77**.

In the object **151**, the surface on the upstream side in the transfer direction **124** varies in position with respect to the engaging portion **156** in the transfer direction **124** on the both sides in the cross direction **121**. A surface **147** on the center side from the engaging portion **156** in the cross direction **121** is located on the downstream side than a surface **148** on the side of the transmission gear **77** in the transfer direction **124**.

At the end of the object **151** on the side of the transmission gear **77** in the cross direction **121**, an abutting section **159** is provided to project above the platen **43**. This abutting section **159** is projected above the platen **43** through a through hole **31** formed to the platen **43**, and the projected end is extended all the way to the position possibly coming in contact with the side surface of the carriage **41**. The through hole **31** is formed to be increased in width in the cross direction **121**. The width of the resulting through hole **31** is so set as to reach the movement area of the abutting section **159** in accordance with the sliding movement of the object **151** in the cross direction **121**.

The release lever **152** is a member configured by three rod members **160**, **161**, and **162**, which are coupled together in the shape of a letter Z. The rod member **161** is incorporated to a shaft **163** to be able to freely rotate. The shaft **163** is the one projecting from the lower surface of the platen **43** in the height direction **122**. The rod member **161** is coupled with, on both ends, the rod members **160** and **162**, respectively. The rod member **160** coupled on the center side in the cross direction **121**, i.e., on the right side in FIG. **15**, is extended from one end of the rod member **161** toward the cam **149**. This rod member **160** is moved close to and away from the cam **149** along the transfer direction **124** in response to the rotation of the rod member **161**. The rod member **162** coupled on the side of the transmission gear **77** in the cross direction **121**, i.e., on the left side in FIG. **15**, is extended from the remaining end of the rod member **161** toward the object **151**. This rod member **162** is moved close to and away from the object **151** along the transfer direction **124** in response to the rotation of the rod member **161**. With the movement of the rod member **162** as such, the release lever **152** is moved close to and away from the object **151**.

To an end of the object **151** on the side of the transmission gear **77** in the cross direction **121**, one end of the coil spring **153** is coupled. This coil spring **153** is extended in the cross direction **121**, and the remaining end thereof is coupled to a spring seat **164** projecting from the lower surface of the platen **43**. As shown in FIG. **15**, the coil spring **153** moves, with its natural length, the detection section **155** of the object **151** from the window **33** of the platen **43** toward the center in the cross direction **121**. That is, by the coil spring **153** with the natural length, the detection section **155** is misaligned from the window **33**. In this case, the abutting section **159** is positioned on the center side of the through hole **31** in the cross direction **121**. When the abutting section **159** is positioned on the side of the transmission gear **77** of the through hole **31** in the cross direction **121**, the detection section **155** is aligned with the window **33**. That is, the detection section **155** becomes visible from the upper side of the platen **43** through the window **33**. Moreover, the engaging portion **156** of the object **151** comes to the position ready for engagement with the release lever **152**. At this time, the coil spring **153** is compressed. By the coil spring **153** compressed as such, the object **151** is elastically biased toward the center in the cross direction **121**.

To an end of the rod member **162** of the release lever **152** on the downstream side in the transfer direction **124**, an end of the coil spring **154** is coupled. This coil spring **154** is extended in the transfer direction **124**, and the remaining end thereof is coupled to a spring seat **165** projecting from the lower surface of the platen **43**. As shown in FIG. **15**, the coil spring **154** biases the rod member **162** as if pulling it to the downstream side in the transfer direction **124**. As a result, the end of the rod member **162** on the downstream side in the transfer direction **124** comes in contact with the surface **147** of the object **151** on the upstream side or the surface **148**.

Cam **149**

As shown in FIG. **16**, the cam **149** is shaped like a disk whose dimension from the shaft **76** of the transfer roller **60** to the outside in the diameter direction varies depending on the rotation phase of the shaft **76**. The cam **149** is formed with a protrusion **146** projecting to the outermost in the diameter direction on the circumferential of the shaft **76**. In any portion other than the protrusion **146**, the cam **149** does not come in contact with the rod member **160** of the release lever **152** no matter in which position the release lever **152** is (will be described later). The protrusion **146** is projected by the length of, when the release lever **152** is put in the lock position that will be described later, coming in contact with the rod member **160**, and moving the rod member **160** in the transfer direction **124** until the release lever **152** is put in the release position.

As shown in FIG. **15**, the release lever **152** is in the release position in the normal circumstances. In the cam **149**, no matter in which rotation phase, the protrusion **146** never comes in contact with the rod member **160** of the release lever **152** in the release position. The object **151** is moved to slide toward the center in the cross direction **121**, and the coil spring **153** has the natural length. The engaging portion **156** of the object **151** is positioned on the center side than the rod member **162** of the release lever **152** in the cross direction **121**, and the rod member **162** is contacting with the surface **148** of the object **151** by being biased by the coil spring **154**.

As shown in FIG. **17**, when the carriage **41** is moved to the end position, i.e., position shown in FIG. **3**, the side surface of the carriage **41** comes in contact with the abutting section **159** of the object **151**, and while compressing the coil spring **153**, moves the abutting section **159** to slide toward the outside of the through hole **31** in the cross direction **121**, i.e., on the left side in FIG. **17**. In response to the sliding movement of the abutting section **159** as such, the object **151** is moved to slide to the outside in the cross direction **121**. During such a sliding movement, the engaging portion **156** of the object **151** comes in contact with the rod member **162** of the release lever **152**. More in detail, the surface **158** of the engaging portion **156** comes in contact with the rod member **162**, and the rod member **162** is pushed by the surface **158** in the direction opposite to the transfer direction **124** against the biasing force of the coil spring **154**. When the end of the rod member **162** on the downstream side in the transfer direction **124** exceeds the engaging portion **156**, by the biasing force of the coil spring **154**, the rod member **162** is moved along the transfer direction **124** until it comes in contact with the surface **147**. In response to such a movement of the rod member **162**, the rod member **160** starts moving along the transfer direction **124** after once moving in the direction opposite thereto. As a result, the release lever **152** is put in the lock position. Due to the engagement between the rod member **162** and the engaging portion **156**, the release lever **152** in the lock position serves to restrict the movement of the object **151** toward the center in the cross direction **121** against the biasing force of the coil spring **153**. With such a restriction, the detection section **155** of the object **151** is aligned with the window **33** so that the detection section **155** can remain exposed above the platen **43** through the window **33**.

As shown in FIG. **18**, the carriage **41** at the end position is moved toward the home position so as to position the sheet detection sensor **32** directly above the window **33**. This moves the carriage **41** away from the abutting section **159** of the object **151** but, as described above, the object **151** is remained at the position where the detection section **155** is aligned with the window **33** by the release lever **152** in the lock position. Thereafter, when the sheet detection sensor **32** is turned on, the sheet detection sensor **32** starts detecting any reflected light of the detection section **155**. The output signal coming from the sheet detection sensor **32** at this time is determined as HI in level.

As shown in FIG. **19**, when the transfer roller **60** is rotated in response to the driving of the LF motor **85**, the cam **149** attached to the shaft **76** is also rotated. Then when the protrusion **146** of the cam **149** comes in contact with the rod member **160** of the release lever **152**, against the biasing fore of the coil spring **154**, the rod member **160** is moved in the transfer direction **124**. This accordingly changes the position of the release lever **152** from lock to release. When the release lever **152** is in the release position, the end of the rod member **162** on the downstream side in the transfer direction **124** is positioned on the upstream side than the engaging portion **156** of the object **151** in the transfer direction **124**. That is, the engagement between the rod member **162** and the engaging portion **156** is released. As a result, the object **151** is moved to slide toward the center in the cross direction **121** by the biasing force of the coil spring **153**. By this sliding movement of the object **151**, the detection section **155** is misaligned from the window **33** so that the portion of the object **151** other than the detection section **155** is exposed through the window **33**. The sheet detection sensor **32** mounted to the carriage **41** stopped in motion at the position corresponding to the window **33** is operated to detect any light reflected by the portion of the object **151** other than the detection section **155**. The output signal coming from the sheet detection sensor **32** at this time is determined as LOW in level.

As described in the foregoing, the cam **149** to be rotated in conjunction with the rotation of the transfer roller **60** moves to slide the detection section **155** of the object **151** exposed above the platen **43** through the window **33** so that the control section **100** can detect the position of an origin of the transfer roller **60** based on any change observed in an output signal coming from the sheet detection sensor **32**.

Third Modified Example

Described below is a third modified example of the embodiment above. Unlike the embodiment above, in the third modified example, as an alternative to the sensing member **90** in the above embodiment, a drum **170** is provided. Also as an alternative to the protrusion **80** of the transmission gear **77**, the shaft **76** of the transfer roller **60** is formed with a spur gear **171**, and for engagement with the spur gear **171**, a transmission gear **172** is provided. The remaining configuration is the same as that of the embodiment above, and thus a detailed description is thus given only about the drum **170**, the spur gear **171**, and the transmission gear **172** but not about the remaining configuration. The drum **170** corresponds to a rotation body being the sensing member as an example of the reference member, and the spur gear **171** and the transmission gear **172** each correspond to the drive transmission mechanism. Note that, in FIGS. **20** and **21**, the gear teeth are not shown, and in FIG. **20**, the components, e.g., the carriage **41** and the platen **43**, are each indicated by broken lines.

Drum **170**

As shown in FIGS. **20** and **21**, the drum **170** is disposed on the lower side of the platen **43**. The drum **170** is a member shaped like a cylinder, and is supported on the lower surface side of the platen **43** to be able to freely rotate with the cross direction **121** being the axial direction. The upper surface of the platen **43** is partially notched on the side of the transmission gear **77** in the cross direction **121**, and the drum **170** placed thereover is exposed with respect to the upper side of the platen **43**. The position of the drum **170** in the transfer direction **124** corresponds to the position of the sheet detection sensor **32** mounted to the carriage **41**. Accordingly, when the carriage **41** is moved to the area in the vicinity of the transmission gear **77**, the drum **170** is opposed to the sheet detection sensor **32**.

As shown in FIG. **21**, the circumferential surface of the drum **170** is partially colored so that a detection section **173** is formed. This detection section **173** is so configured as to have a reflectivity different from that of other remaining components. This is for the detection section **173** to output an electric signal of varying level between when the sheet detection sensor **32** is opposing the detection section **173**, and when it is opposing the other remaining components. In this embodiment, the detection section **173** is colored white, and the other remaining components are each colored black.

On one end side of the drum **170** in the axial direction, a spur gear **174** is formed. The shaft **76** of the transfer roller **60** is provided with the spur gear **171**. This spur gear **171** is disposed in line with the spur gear **174** along the transfer direction **124**. In such a manner as to couple together these spur gears **171** and **174**, the transmission gear **172** is provided. With such a configuration, the rotation of the shaft **76** of the transfer roller **60** is transmitted to the drum **170**. The rotation to be transmitted from the shaft **76** to the drum **170** as such by the spur gears **171** and **174**, and by the transmission gear **172** is so proportionally set that the drum **170** makes a rotation while the shaft **76** makes N rotations (where N is a natural number).

As shown in FIGS. **20** and **21**, in the carriage **41** at the end position, the sheet detection sensor **32** is opposing the drum **170**. When the sheet detection sensor **32** is turned on, the sheet detection sensor **32** starts detecting any reflected light from the drum **170**. When the transfer roller **60** is rotated due to the driving of the LF motor **85**, the rotation of the shaft **76** is transmitted to the drum **170** via the gears, i.e., the spur gear **171**, the transmission gear **172**, and the spur gear **174**. As described in the foregoing, in response to the rotation of the shaft **76** for N times, the drum **170** makes a rotation. During the rotation of the drum **170** as such, the detection section **173** is opposed only once to the sheet detection sensor **32**. When the sheet detection sensor **32** is operated to detect any light reflected by the component(s) other than the detection section **173**, an output signal coming from the sheet detection sensor **32** is determined as LOW in level. Moreover, when the sheet detection sensor **32** is operated to detect any light reflected by the detection section **173**, the output signal coming from the sheet detection sensor **32** is determined as HI in level. Based on any change observed as such in the output signal from the sheet detection sensor **32**, the control section **100** can determine the position of an origin of the transfer roller **60**.

Note that, in the embodiment and the modified examples described above, described is the configuration in which the sheet detection sensor **32** is operated to detect a reflectivity. Alternatively, any sensor provided for detecting a distance to the detection target may be used as the sheet detection sensor **32**. If this is the configuration, the detection section **155** of the object **151**, and the detection section **173** of the drum **170** may be made uneven so as to differ the distance to the sheet detection sensor **32** from the other remaining components.

What is claimed is:

1. An image printing device, comprising:
a transfer roller configured to transfer a printing medium in a transfer direction;
a driving source which rotates the transfer roller;
a first sensor configured to detect a rotation amount of the transfer roller;
a printhead which performs image printing onto the printing medium transferred by the transfer roller;
a carriage configured to move in a movement direction intersecting the transfer direction, the carriage being mounted with the printhead;
a second sensor mounted to the carriage, the second sensor being configured to detect the printing medium;
a reference member disposed at a position opposing to the second sensor;
a drive transmission mechanism configured to move the reference member in conjunction with a rotation of the transfer roller; and
a controller configured to control the driving source, the printhead, and the carriage,
wherein the controller is configured to:
move the carriage to a detection position where the second sensor detects the reference member;
drive the driving source to move the reference member via the drive transmission mechanism; and
determine the position of the origin of the transfer roller based on a detection result of the first sensor, and a detection result of the second sensor.

2. The image printing device according to claim **1**, further comprises a memory which stores a correlation between a rotation phase corresponding to a rotation amount of the transfer roller from the position of the origin and a correction value for a target rotation amount of the transfer roller,
wherein, based on the determined position of the origin, the detection result of the first sensor, and the correlation stored in the memory, the controller is configured to correct the target rotation amount of the transfer roller, and to drive the driving source in accordance with the corrected target rotation amount of the transfer roller.

3. The image printing device according to claim **1**, wherein the printhead performs the image printing by an ink-jet mode,
the image printing device further comprises an ink receiving section configured to oppose the printhead when the carriage is at the detection position, and
the controller controls the printhead to discharge ink drops from the printhead to the ink receiving section while the position of the origin is detected.

4. The image printing device according to claim **1**, wherein the drive transmission mechanism moves the reference member with respect to the carriage in accordance with a predetermined rotation position of the transfer roller.

5. The image printing device according to claim **1**, wherein the reference member comprises a rotation body, and
the drive transmission mechanism rotates the reference member in conjunction with rotation of the transfer roller.

6. The image printing device according to claim **1**, wherein a physical amount to be detected by the second sensor is a reflectivity or a distance of the reference member.

7. The image printing device according to claim **1**, wherein the second sensor comprises a light-emitting portion which emits a light and a light-receiving portion which receives a reflected light and outputs a signal in accordance with an amount of the reflected light.

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